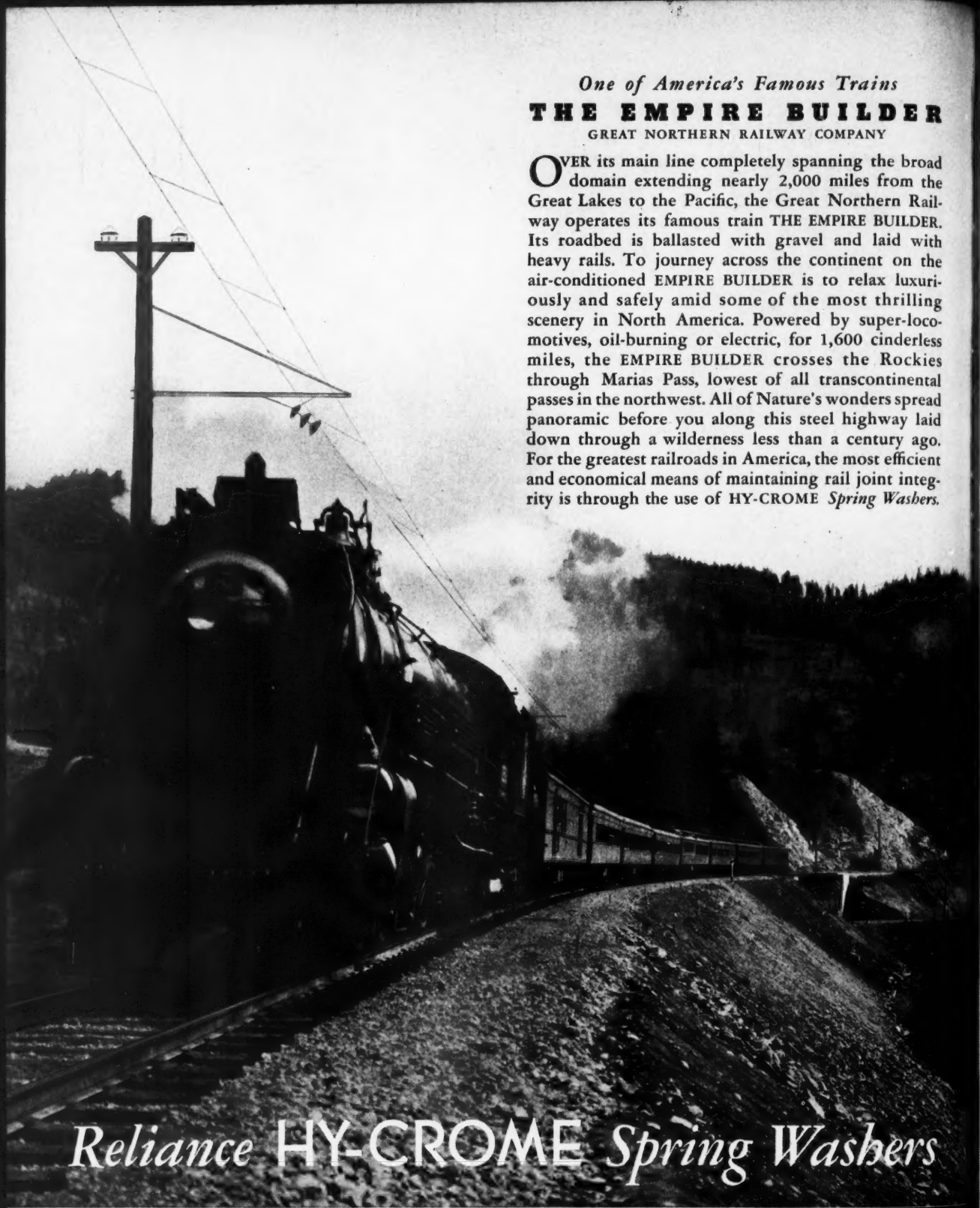


One of America's Famous Trains

THE EMPIRE BUILDER

GREAT NORTHERN RAILWAY COMPANY

OVER its main line completely spanning the broad domain extending nearly 2,000 miles from the Great Lakes to the Pacific, the Great Northern Railway operates its famous train THE EMPIRE BUILDER. Its roadbed is ballasted with gravel and laid with heavy rails. To journey across the continent on the air-conditioned EMPIRE BUILDER is to relax luxuriously and safely amid some of the most thrilling scenery in North America. Powered by super-locomotives, oil-burning or electric, for 1,600 cinderless miles, the EMPIRE BUILDER crosses the Rockies through Marias Pass, lowest of all transcontinental passes in the northwest. All of Nature's wonders spread panoramic before you along this steel highway laid down through a wilderness less than a century ago. For the greatest railroads in America, the most efficient and economical means of maintaining rail joint integrity is through the use of HY-CROME *Spring Washers.*

Reliance HY-CROME *Spring Washers*

REActive Deflected	THACKERAY	HY-REACTION	STANDARD	HEAVY DUTY	DOUBLE	BON
Meets A. R. E. A. Spec.	*For screw spike use*	*For track bolts*	*For general use*	*For frogs—crossings*	*For special use*	*Used as*

EATON MANUFACTURING CO. RELIANCE SPRING WASHER DIVISION, MASSILLON, O.

Sales Offices: New York • Cleveland • Detroit • Chicago • St. Louis • San Francisco • Montreal

MEETS HIGH SPEED TRAFFIC REQUIREMENTS AND EVERYDAY ECONOMIC NEEDS

LUNDIE TIE PLATES meet these two specific needs. For higher train speeds, Lundie Plates maintain a refinement of surface which results in non-spreading, smoother and easier riding track. . . . . To meet everyday economic needs for lower costs, Lundie Plates insure maximum strength at lowest cost. The complete elimination of sharp projections minimizes tie destruction and the superior service in track saves on maintenance expenses in regauging and surfacing. . . . By specifying Lundie Plates you are assured of immediate as well as continued economies.

THE LUNDIE ENGINEERING CORPORATION

Tie Plates—Ardco Rail and Flange Lubricator

19 West 50th St., New York 59 E. Van Buren St., Chicago

LUNDIE TIE PLATE

Published monthly by Simmons-Boardman Publishing Company, 105 W. Adams St., Chicago, Ill. Subscription price, United States and Possessions, and Canada, $2.00; Foreign $3.00. Single copies 35 cents. Entered as second-class matter January 20, 1933, at the postoffice at Chicago, Illinois, under the act of March 3, 1879, with additional entry at Mt. Morris, Ill., postoffice. Address communications to 105 W. Adams St., Chicago, Ill.

Rail Laying and Tie Tamping Cost MUCH Less With I-R PNEUMATIC EQUIPMENT

LONG experience on many roads has demonstrated definitely that I-R Pneumatic Tools not only make big savings in general track work but produce far better and more permanent construction.

I-R Tools which speed-up and reduce the cost of rail laying include the speedy spike puller, powerful wrenches for bolting and unbolting, fast spike drivers for cut or screw spikes, wood borers, rail drills, etc.—a complete line of air tools which assure worthwhile savings in every operation.

In tie tamping, I-R Air Compressors and Tie Tampers have shown considerable savings right from the initial changeover from hand to pneumatic tamping. On subsequent tie tampings the savings are far greater and you are assured a thoroughly tamped track which lasts much longer without attention. Greatest economies are now being procured from the combined use of the I-R two-stage, air-cooled Compressors and the MT-3 low-air consumption Tie Tampers.

Birmingham, Boston, Butte, Chicago, Cleveland, Dallas, Denver, Detroit, Duluth, Tulsa, El Paso, Knoxville

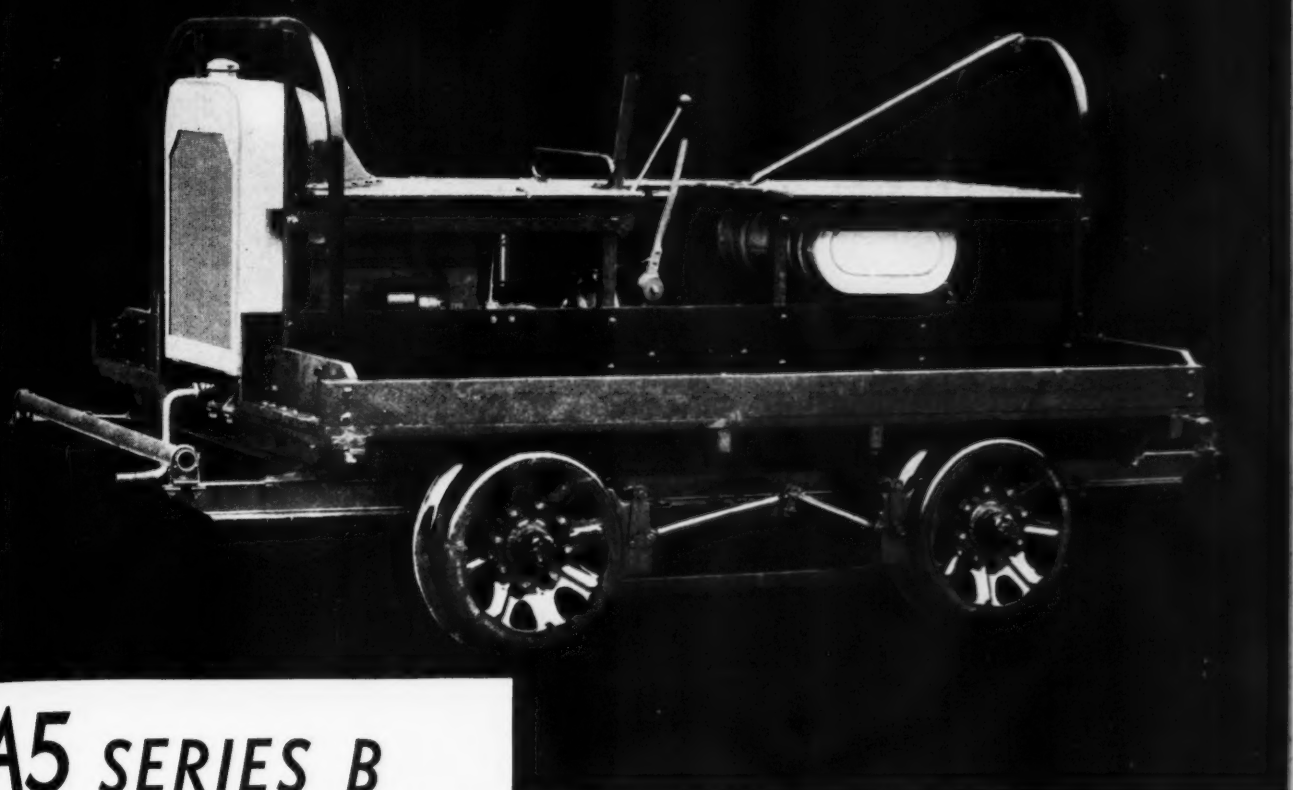
Ingersoll-Rand

11 BROADWAY, NEW YORK CITY

Los Angeles, Newark, New Orleans, New York, Philadelphia, Picher, Pittsburgh, Salt Lake City, San Francisco, Scranton, Seattle, St. Louis, Washington

418-11

PERFORMANCE ON THE JOB COUNTS

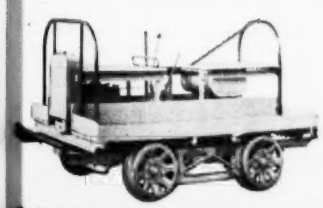


A5 SERIES B

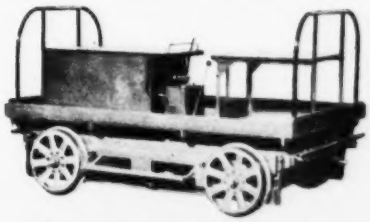
GANG CAR — 32 H. P. . . . REAR LIFT 394 POUNDS

No other car in the field has the flexibility of power and of service delivered by this A5. • It is the only car in its class equipped with the Fairmont Reverse Gear for 4 all-gear-driven speeds in either direction. • This exclusive Fairmont feature, in conjunction with the 32 H.P. Waukesha Engine, means more than easy starting under heavy load and the saving of costly time in getting men to the job ... it equips the A5 for a broader scope of service ranging from hump-yard work to any towing job lighter than gang discing attachments. • Likewise, it is the only car in its field with these outstanding features . . . a center cockpit control with clear vision front and rear; a differential loose wheel axle; iron lined brake shoes for definite cushioned grip in all weathers; demountable wheels and bolted frame construction for quick and easy field adjustments. • Again, Fairmont skill in engineering and design is reflected in the fact that, in eight years of service, this A5 has been changed only for improvement by the addition of modern refinements. • Fairmont Railway Motors, Inc., Fairmont, Minnesota.

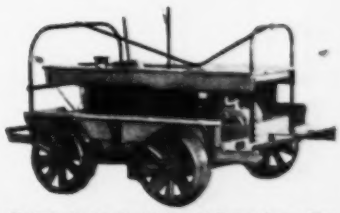
Inspection Motor Cars . . . Section Motor Cars . . . B & B and Extra Gang Cars . . . Gas-Electric Ditchers . . . Shapers . . . Ballast Cleaners . . . Ballast Drainage Cars . . . Mowers . . . Weed Burners . . . Extinguisher Cars . . . Power Cars: Air, Electric, Paint Spray, Tie Tamping . . . Rail Coaches . . . Motor Car Engines . . . Push Cars and Trailers . . . Roller Axle Bearings . . . Wheels and Axles.



● A3 Series B — B&B and Extra Gang Car



● A6 Series B — 80 H. P. Gang Car



● ST2 Series D—B&B and Extra Gang Car

ALL THE RAILWAY MOTOR CARS IN SERVICE TODAY

Fairmont

More than Half are Fairmonts

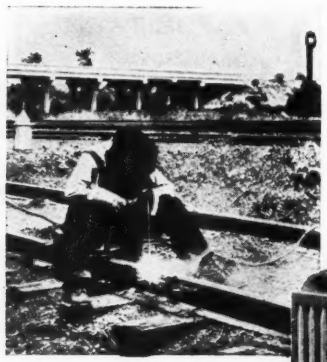
G-E ARC WELDERS

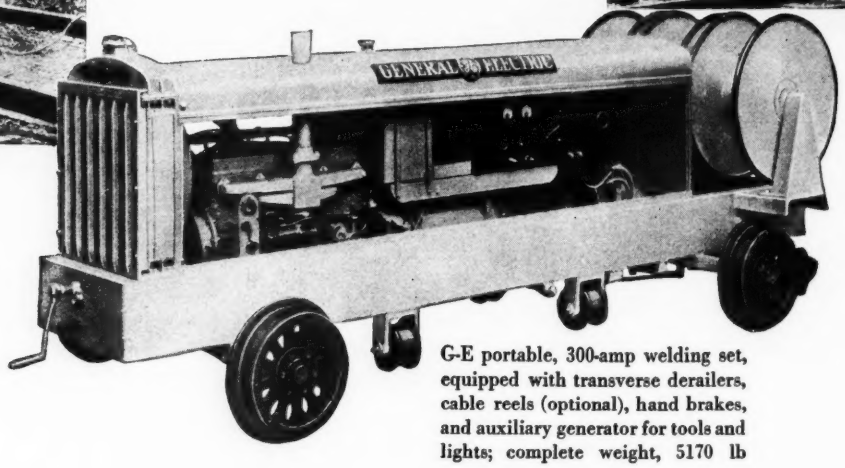
and Bridge Repair . .

G-E railroad-type welders are complete, self-contained power plants for maintenance-of-way welding operations, for either one or two operators. They can be supplied with sufficient auxiliary power for operating grinders, slotters, or other tools.

Economical operation is assured because they are equipped with the popular Type WD welding generator, which has the minimum of rotating parts. The performance of this generator is unexcelled with the bare, lightly fluxed, or heavily coated electrodes required for railroad welding applications.

Extreme portability characterizes the complete line of G-E railroad-type welders. Whether they are tractor, crawler, or on-track type, they have the minimum weight consistent with their capacity for continuous performance under severe operating conditions. They can be easily and quickly removed from the track, as occasion demands.



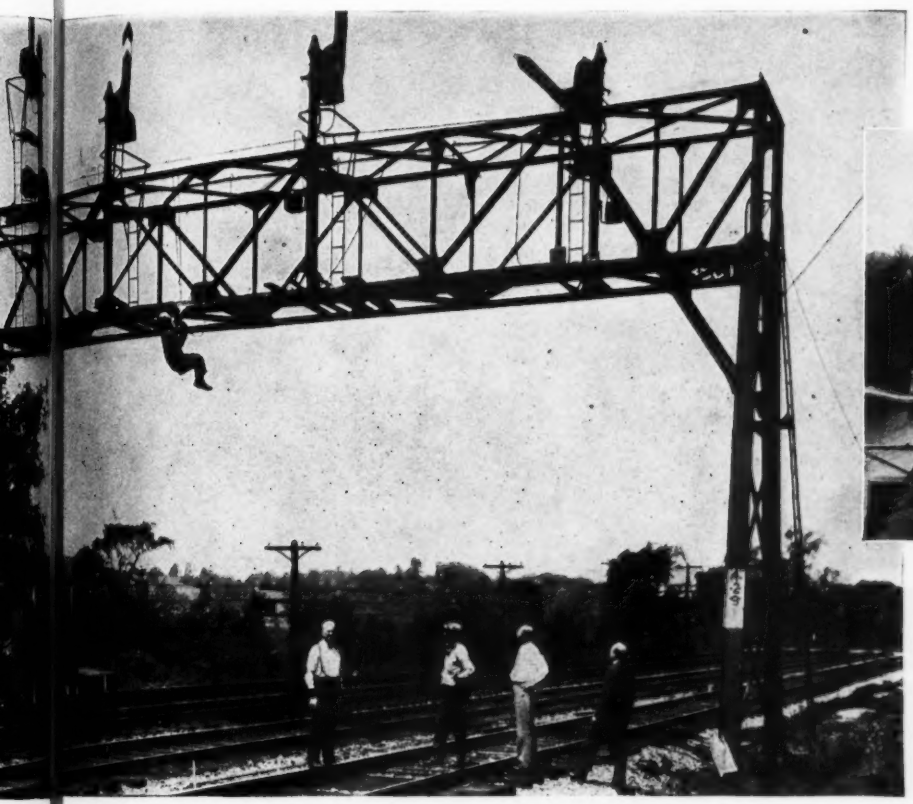


G-E portable, 300-amp welding set, equipped with transverse derailers, cable reels (optional), hand brakes, and auxiliary generator for tools and lights; complete weight, 5170 lb

G E N E R A L

Simplify Track Maintenance

. . CUT COSTS, TOO



Installing new bottom lateral system and lower chords of trusses on railroad signal bridge by electric arc welding, to strengthen the existing structure

EXPERIENCE IS NEEDED

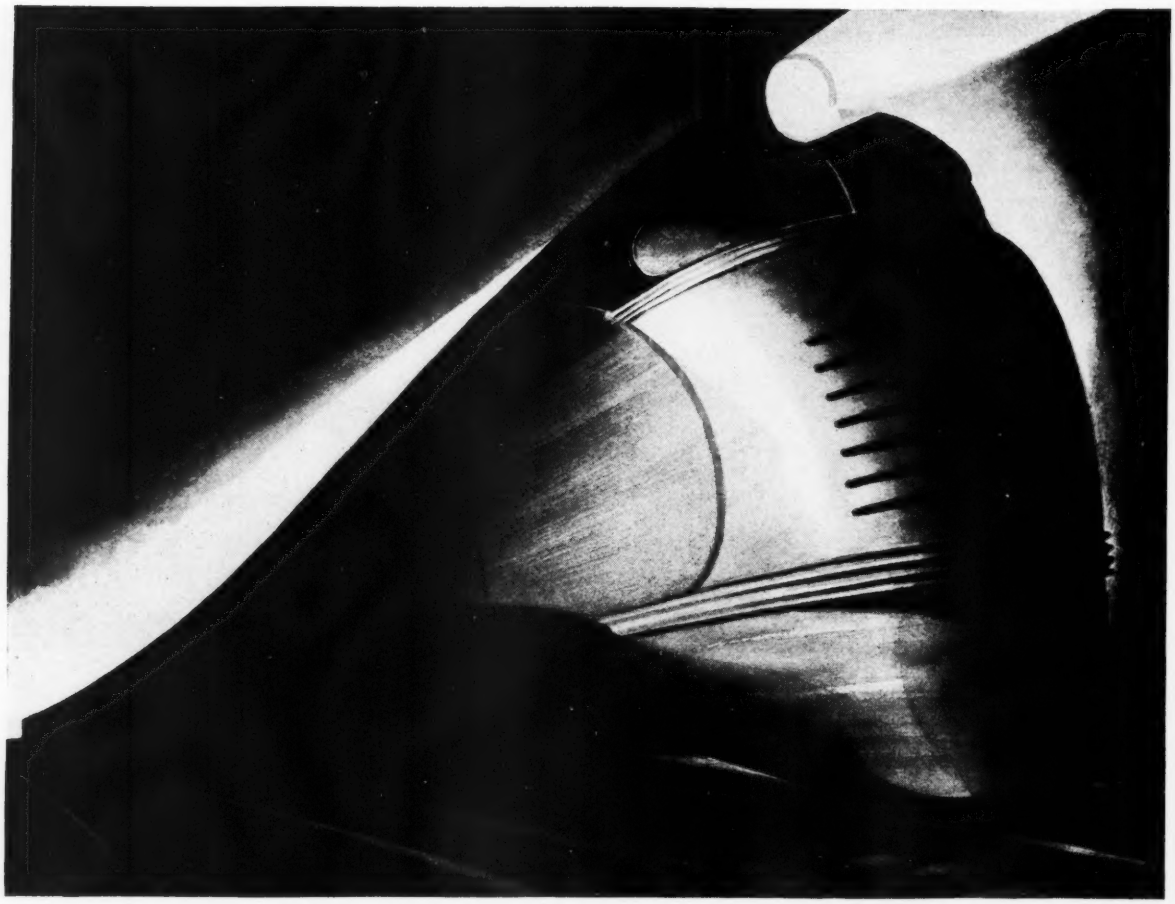
In G-E welding equipment and electrodes lies more than mere nicety of design, for they are built on the solid foundation of years of experience with electric welding—experience involving years of engineering research and development, followed by actual use. From small pipe lines to large turbines —this is the scope of application of electric welding in G-E factories.

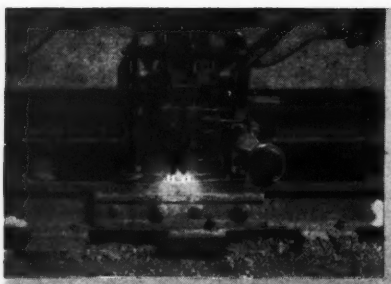
The fundamentals of all welding problems are very much alike—your requirements and ours are essentially the same. We have helped many railroads reduce maintenance and repair work—resulting in faster and better work at a lower cost. General Electric is at your command, with its improved welding equipment and electrodes and its long engineering experience. General Electric, Schenectady, New York.

140-42

L E L E C T R I C

Smooth-Riding





RAIL END HARDENING—Hardening the ends of new rail by the Oxweld Process reduces batter and adds years of smooth, efficient life. Wear on the under side of the rail head and on top of the joint bar becomes negligible. The unit cost is less than 25 cents per joint.

HIGH SPEED RAIL BONDING — A bond made by the oxy-acetylene process stays bonded . . . assures permanent trouble-free electrical connection between the rail ends. Oxweld Railroad Service has developed improved methods for bonding rail quickly at low cost.

RECLAIMING WORN FROGS — Battered frogs are easily built up by oxy-acetylene welding with Oxweld M. W. Welding Rod. This Oxweld procedure makes old frogs better than ever at a fraction of the cost of new ones. Annual savings amount to thousands of dollars.

Track by OXWELD

for modern high-speed trains

MODERN trains traveling at ever-increasing speeds demand batter-free, smooth-riding track. Safe transportation also is a constant responsibility. To keep pace with the exacting demands of today's high speed traffic and the self-imposed obligation of safety, the most advanced methods of track maintenance are vitally essential.

Many Economies in Track Maintenance

For over twenty years, The Oxweld Railroad Service Company has played a leading part in the attainment of safety and maximum efficiency in maintenance-of-way work. Through close cooperation with maintenance departments, this railroad-minded organization has contributed its special talents and experience to the progressive advancement of maintenance methods. This has resulted in the adoption of Oxweld Processes for building up rail ends, reclaiming worn angle bars, building up worn switch points and frogs, rail end hardening, and rail bonding, as standard procedures for track work on most Class I railroads. Even when considered individually, Oxweld Processes for these operations show astounding savings.

Oxweld Railroad Service Cooperation

The Oxweld Railroad Service Company is in a position to assist its Railroad clients in organizing this type of work, in the field or shop, to obtain maximum economy in all operations.

Equipment, materials, and supplies of the highest quality and of maximum operating efficiency, as well as the benefits of over twenty years of experience and research in railroad welding, are available through The Oxweld Railroad Service Company. For almost a quarter of a century, a majority of Class I railroads have been Oxweld contract customers.

THE OXWELD RAILROAD SERVICE COMPANY

Unit of Union Carbide and Carbon Corporation

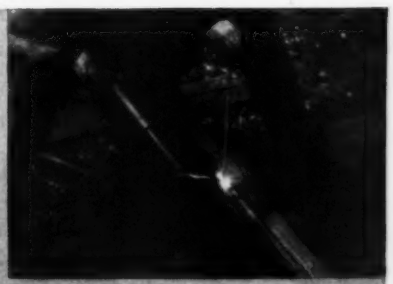
UCC

New York: Carbide and Carbon Bldg. Chicago: Carbide and Carbon Bldg.

OXWELD RAILROAD SERVICE

BUILDING UP RAIL ENDS—Oxy-acetylene welding makes battered rail ends ride like new . . . and the built-up end is harder and wears longer than the original rail. During the last year thousands of miles of track were renewed in this easy economical way by Oxweld Railroad Service.

RECLAIMING WORN ANGLE BARS—Worn angle bars are reclaimed by oxy-acetylene welding at a fraction of the cost of replacement. With wear-resistant Oxweld M. W. Welding Rod, the bars are rebuilt to provide a made-to-order fishing surface that wears better than new.



BUILDING UP WORN SWITCH POINTS—These critical points of wear are easily made like new under Oxweld procedures. Built up by oxy-acetylene welding with Oxweld M. W. Welding Rod, they wear longer than before . . . and cost much less than new ones.

fewer dollars needed

Above: Exterior view of one of almost limitless types and sizes of Truscon Standard Buildings erected with speed and rock-bottom economy.

Below: Interior view of Truscon Standard Building illustrating structural characteristics and clear-span interior.

TRUSCON LINE OF STEEL BUILDING PRODUCTS COVERS EVERY RAILROAD BUILDING REQUIREMENT

To own a TRUSCON Standard Building

TRUSCON principles of standardized building construction are of special value to railroads. Economies assured by large-scale production methods and rapid erection in any kind of weather are two examples. Other advantages include adaptability of Truscon standard units to meet any requirement for type and size of fire-safe building . . . any arrangement of doors and windows . . . any kind of sidewalls and any type of roof design. (Truscon Standard Buildings are ideal warehouses for fruit storage and other perishable products. This is but one of hundreds of uses for these weather-tight structures).

Built of copper alloy steel units and further protected against rust and corrosion by a base panel of ENDURO Stainless Steel . . . every Truscon Standard Building is assured of low cost maintenance and long life. Other advantages are ease of enlargement and . . . whenever conditions require . . . ease of dismantling and re-erection in new locations with practically *100% salvage value!*

Truscon Steeldeck Roofs merit special mention. Made of rust and corrosion resisting copper alloy steel; they are permanent, trouble-free, fire-safe and light in weight. (Covered with insulation and waterproofing they weigh only 5 pounds per square foot).

Check up on ALL the advantages of Truscon Standard Buildings for Railroads. Truscon engineers are near you in one of Truscon's 54 sales-engineering offices. USE THEIR EXPERT CO-OPERATION!

TRUSCON STEEL COMPANY • YOUNGSTOWN, OHIO

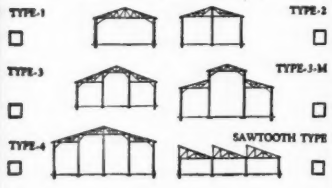
If you are unfamiliar with the location of the Truscon sales offices in your locality, write to Truscon Steel Company, Youngstown, Ohio.

USE THIS FOR PROMPT REPLY

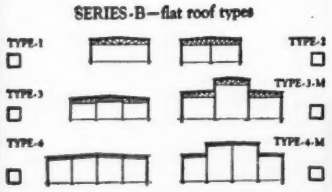
We are interested in the type of building checked below.

Length.....Width.....Clear Height.....

SERIES-A—pitched roof types



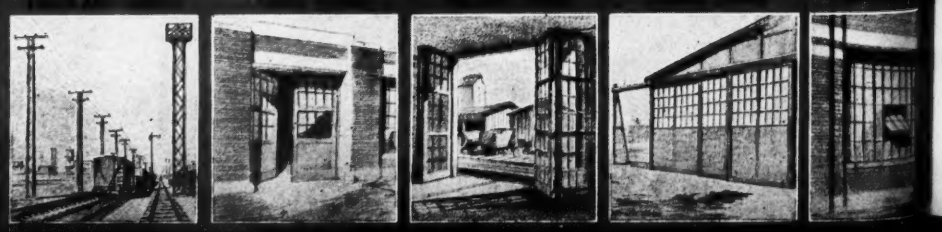
SERIES-B—flat roof types



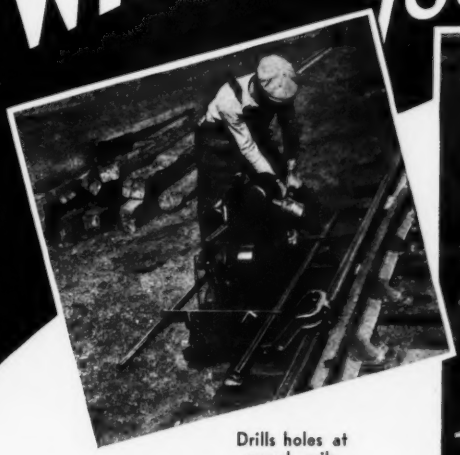
☐ We are interested in the Truscon-FHA plan of financing through the Equipment Acceptance Corporation.

Name.....

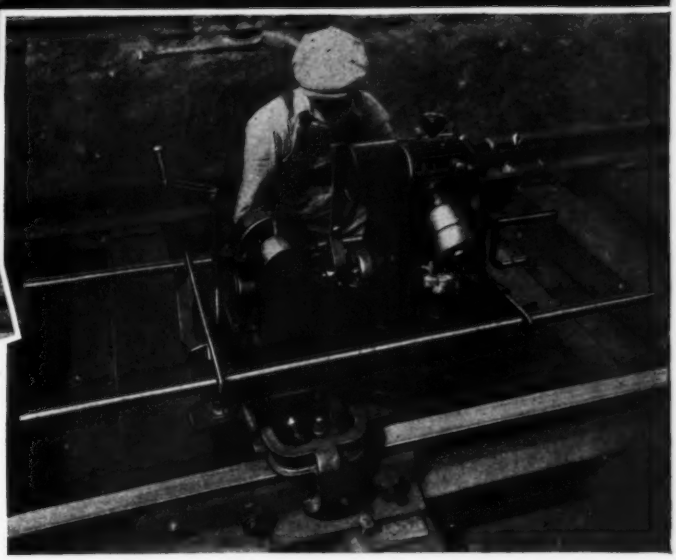
Address.....



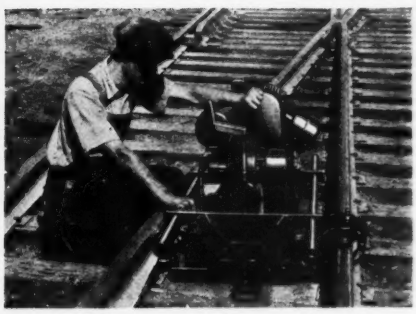
When Drilling Holes for Track Bolts



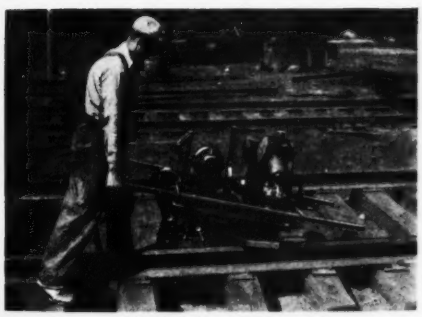
Drills holes at guard rails.



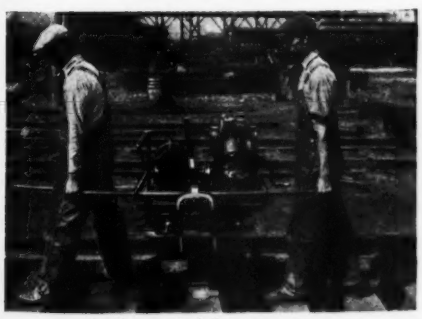
Wherever a track bolt hole is to be drilled, it is only necessary to set the drill in position, attach the clamp, adjust for height, throw in the clutch, and start the automatic feed. A one inch hole can be drilled in a minute.



Close quarters at a switch.



Wheeled by one man.



Easily carried by two men.

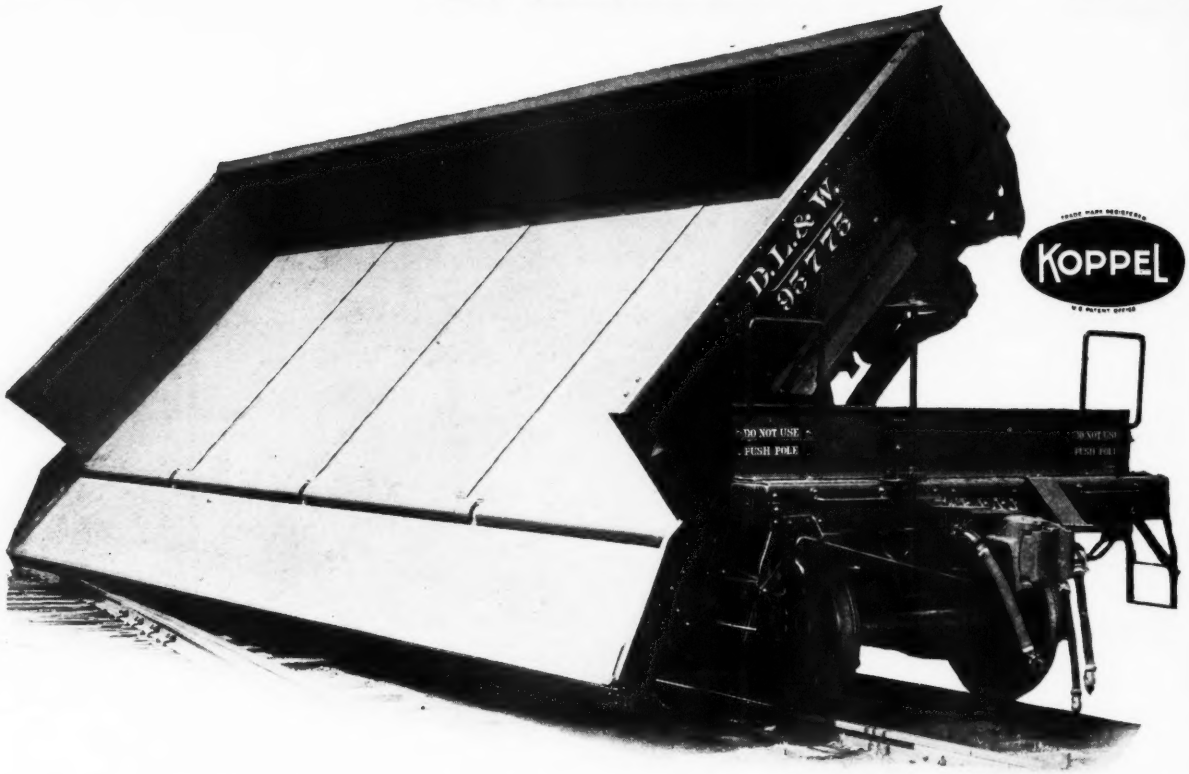
The features of simplicity, convenience, speed, and accuracy recommend the Nordberg Power Rail Drill wherever track bolt holes must be drilled on maintenance work. It gets to all the holes whether at switches, crossings, or guard rails. No expert mechanic is required to set it up. Any man in the gang can operate it. Just clamp it on and it is ready to go. It is much faster than any other method of drilling. Its quick setup and ample power makes fast progress possible. It is easily moved about the job. Wheel it along the rail as a wheelbarrow or, with the lifting handles provided, it is a light load for two men. With the rail laying gang, around yards or at terminals, this little machine soon pays for itself in time and labor saved.

In addition to this drill, Nordberg has developed eight other machines for track maintenance work.

POWER JACK	BOLT TIGHTENER	ADZING MACHINE
SPIKE PULLER		POWER WRENCH
TRACK CRANE	RAIL GRINDER	TRACK SHIFTER

NORDBERG MFG. CO.

MILWAUKEE, WIS.



KOPPEL AIR DUMP CARS

Offer Maximum Savings

SAVE time and money on many of your jobs—grading, ditching, new construction, filling in trestles and embankments. You will find no other facilities which offer greater economies in the handling of materials than KOPPEL Air Dump Cars.

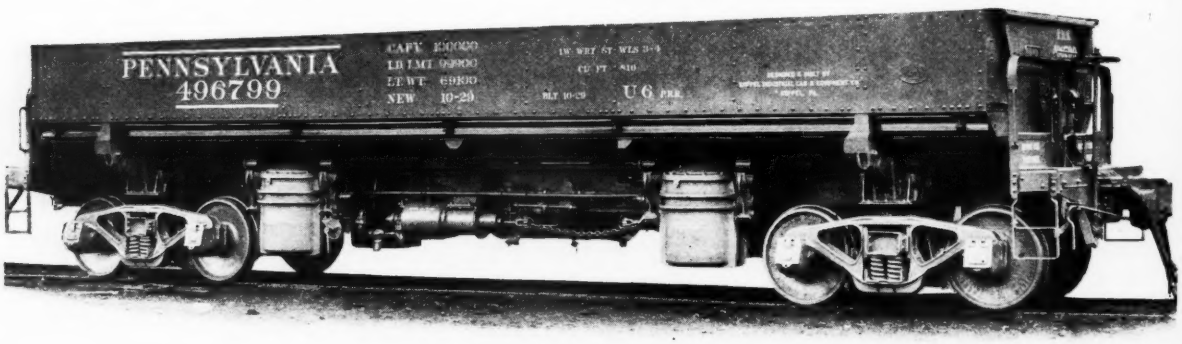
Ballast, gravel, cinders, sand, heavy rock and often revenue pay loads are transported with absolute safety and dumped for a minimum cost.

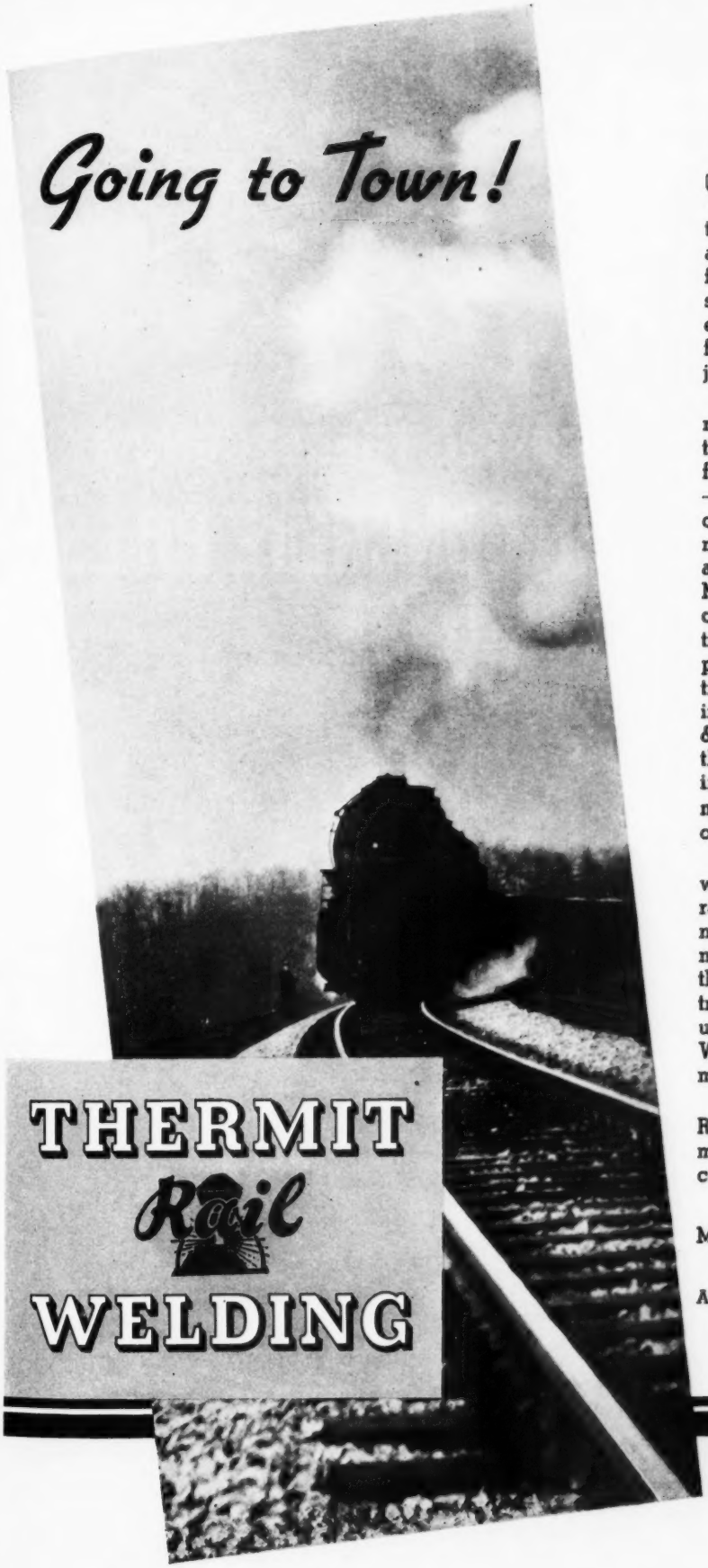
KOPPEL Air Dump Cars are made in various sizes ranging from 12 to 50 cu. yd. in capacity. Leading railroads are showing preference for the 50 yd. car due to the fact that fewer units are required and that the cost per cu. yd. of handling materials is naturally lower than with smaller cars.

KOPPEL Air Dump Cars can be purchased on convenient terms if desired or leased for any period. We are also equipped to repair or rebuild all types of cars: Air Dump, Hoppers, Gondolas, etc.

Koppel Industrial Car & Equipment Company

General Offices: **Koppel, Pennsylvania** *District Offices:* **New York - Pittsburgh - Chicago**





THERMIT Rail Welding is making rapid progress. Interest in continuous rails is growing by leaps and bounds. Important railroads are fast becoming convinced both of the savings to be gained through the elimination of rail joints and of the feasibility of welding rails into long jointless stretches.

This year, four more roads join the ranks of the pioneers in Thermit welded track: the Erie Railroad, with a 5300 ft. stretch in a tunnel at Otisville, N.Y. —the Northern Pacific, with continuous rails in two tunnels, each approximately 4000 ft. long, at Livingston and at Elliston, Montana—the Chicago, Milwaukee & St. Paul, with a half mile of welded track at the Milwaukee station—the New York Rapid Transit Corporation, with a half mile of double track in an open cut on a subway line in Brooklyn. In addition, the Delaware & Hudson, continuing the work started three years ago, has put in a fifth installation near Comstock, N. Y., making a total of nearly twelve miles of welded rails installed by this road.

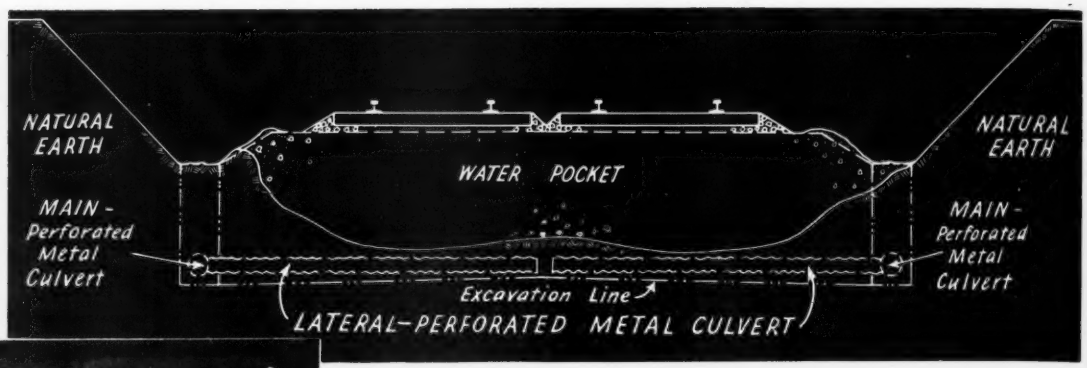
These installations are pointing the way to enormous savings. Long welded rails have no gaps for wheels to pound; no rail ends to batter. Joint maintenance is banished because the joints themselves are eliminated. Frequent track lining and surfacing become unnecessary. Rail life is increased. Wear and tear on rolling stock and motive power are reduced.

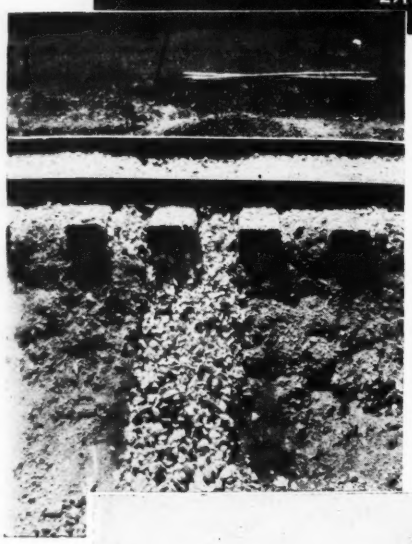
It will pay you to investigate Thermit Rail Welding. Write now for full information. Or, ask to have a representative call and give you the complete story.

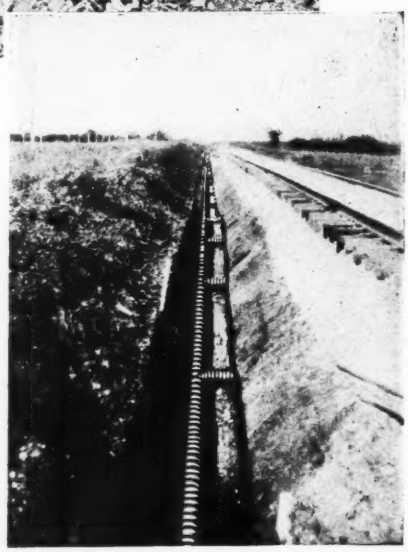
METAL & THERMIT CORPORATION
120 BROADWAY, NEW YORK

ALBANY • CHICAGO • PITTSBURGH
SO. SAN FRANCISCO • TORONTO

LOWER MAINTENANCE COSTS with a properly drained roadbed







When the track is unstable and will not carry its grade or alignment through cuts, the cause is generally defective drainage. Water seeping from drainage ditches and rain water are detained in water pockets, making a plastic mass which absorbs the ballast under the ties. Around the ties, especially at joints, water and mud are often pumped to the surface under heavy traffic.

The remedy is a series of Toncan Iron Perforated Culverts installed through the cut. Mains, paralleling the track, are laid well below the level of water pockets. Laterals are laid at intervals of 20 feet under and at right angles to the track and connected to mains. Back-fill may be stone, gravel or slag.

Such a system of Toncan Iron Culverts will restore the track to a stable condition and, because Toncan Iron is a rust-resisting alloy of refined alloyed copper and molybdenum, it will last for years. And because of its flexibility, it will not fail under the vibration and pounding of heavy traffic. It will reduce maintenance cost and prove far more economical than less scientifically designed drains. Additional information will gladly be supplied upon request.

Upper view—Lateral showing perforated culvert in place with back-fill of crushed stone.

Lower view—Main showing perforated culverts to which laterals connect for back-fill.

REG. U.S. PAT. OFF.
TONCAN
COPPER MOLYBDENUM
IRON
CORRUGATED PIPE

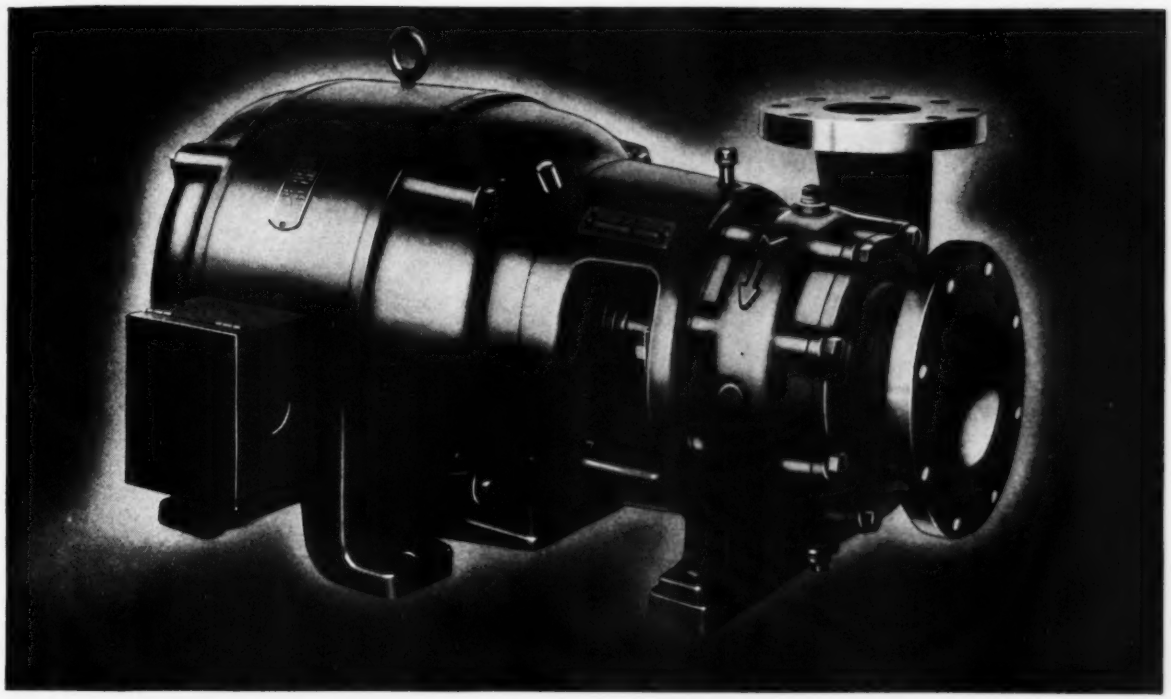
See The Republic Steel Corp. Exhibit at the Track Supply Show—Chicago—Sept. 15-16-17

TONCAN CULVERT MANUFACTURERS' ASSOCIATION

REPUBLIC BUILDING CLEVELAND, OHIO

TONCAN IRON—A PRODUCT OF THE REPUBLIC STEEL CORPORATION

BUILT TO HANDLE A tough job



When railroads and industry demanded a motor-driven pump that would go into an exposed working position, mount in any position or angle, and still handle up to 1000 g.p.m., our engineers started from the bottom up.

They designed a highly efficient side suction centrifugal pump with a bronze impeller. Then they mounted it directly on the shaft of a Fairbanks-Morse splashproof motor. There are no flexible couplings or alignment problems to contend with. The rotating element is ball bearing mounted and requires only one or two greasings a year.

Requiring no foundation, this pump needs only to be bolted into place, its suction and discharge lines connected, and it is ready for operation.

For full particulars on what these "5550" built-together pumps can do, address Railroad Sales, Fairbanks, Morse & Co., 900 S. Wabash Avenue, Chicago, Illinois.

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Pumps

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It Wont go 'round

Maintenance allotments are increasing. Larger programs are in the making. Expenditures will be markedly larger in 1937.

But the needs are many. New rail—more ties—additional ballast—bridge repairs—painting—ditching—more work equipment—drainage—and all the other needs of a railroad that is not only facing increasingly severe traffic requirements but is emerging from six years of restricted upkeep. They will exceed the most optimistic estimate of the funds that will be available.

Which of these many demands should come first? Which will yield the greatest returns in improved tracks and structures—in economy of maintenance? This is the problem confronting every maintenance officer, whether he be roadmaster, division engineer, engineer maintenance of way, or chief engineer.

These men are now thinking of 1937. They are beginning to plan their programs. Their problem is one of selection.

Are you insuring that your products will be considered? Are you presenting to these maintenance officers month after month through the magazine which they read first of all, the story of your products and the economies they will effect?

RAILWAY ENGINEERING AND MAINTENANCE—IS READ BY MAINTENANCE OFFICERS OF ALL RANKS

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● If you are looking for a drainage structure that will meet railway requirements better than any you've ever used, specify Asbestos Bonded Armco Paved Invert Pipe.

Why *Asbestos Bonded?* Chiefly because this improved corrugated iron pipe is paved and fully coated with a special bituminous material. It resists erosion . . . shuts out acids and alkalies. What's more, this special material is actually "bonded" to the pipe in such a manner that it *will stick indefinitely*—in handling, in storage and in service. A permanent seal against Nature's destructive forces!

Remember, too, that *Asbestos Bonded* pipe is made of rust-resisting Armco Ingot Iron—proved in railway service for more than a quarter-century. Add to this the great strength and installation economy of corrugated metal and you have a pipe that simply cannot be equaled for railway drainage purposes. Get the complete story from our nearest office listed below.

Resists Cold—Even though this Asbestos Bonded sample was frozen to 0° F., the impact of a steel ball, weighing nearly 2 pounds, failed to cause any spalling or cracking of the bituminous material on the inside of the sample. The ball dropped 7½ feet.

INGOT IRON RAILWAY PRODUCTS CO.

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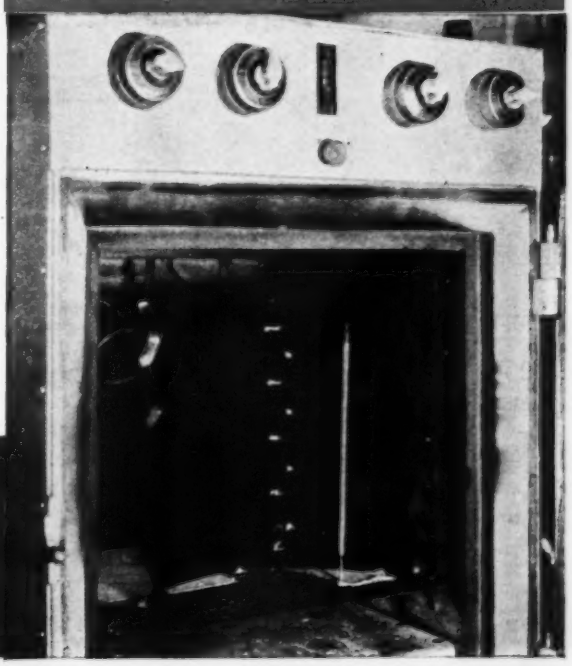
★ ★ ★

Resists Heat—After 4 hours in an electric furnace, at 180° Fahrenheit, the bituminous material on this Asbestos Bonded sample sagged less than a quarter of an inch. Here is proof that Armco's special protection resists much higher temperatures than you would ever encounter in the field.



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The OSMOSE Process for Wood Preservation

A new method of treating wood with well-known, time-tested salt preservatives. Requires no plant or equipment. Secures penetration comparable in depth and effectiveness to that obtained with pressure treatment.

For Green Wood

Eliminates long periods of air-seasoning and the possibility of pre-infection before treatment . . . leaves wood with a clean, dry surface . . . is applicable to any species of wood . . . makes possible the use of timber available near source of consumption.

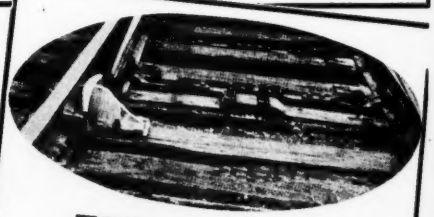
For Standing Poles and Piling

An easy-to-apply groundline treatment that prolongs service-life by arresting existing decay and preventing further decay for a period of years. Economical . . . and positive in its results.

THE "BUDDY"

Oil-Burning PORTABLE HEATER

Burns cheap carbon oil. Renewable fire brick lining. Heats rail end to 400°F in 3 minutes. Saves acetylene and oxygen by pre-heating before gas welding.



TREGO Switch Point GUARD

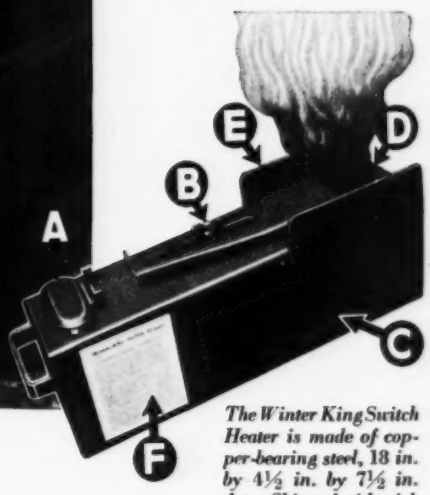
As the GUARD RAIL protects the FROG POINT, so the TREGO GUARD protects the SWITCH POINT. Can be applied to worn stock rail . . . not necessary to replace worn switch point. Lessens danger of splitting the switch because wheel flange is drawn away from the point.

MORRISON RAILWAY SUPPLY CORP.

MORRISON BLDG., BUFFALO, N.Y. — MORRISON RAILWAY SUPPLY CORP. — 20 W. JACKSON BLVD., CHICAGO

The time to lick Blizzards is before they come

Sixteen inches of snow in 1½ days didn't bother the switches at one large terminal where 4000 Winter Kings were burning.



The Winter King Switch Heater is made of copper-bearing steel, 18 in. by 4½ in. by 7½ in. deep. Shipped with wick in place, ready for immediate installation.

install Winter Kings now

WINTER King Switch Heaters are an inexpensive, efficient way of keeping switches clear of ice and snow. They fit under the switch, between the ties—six to eight heaters per switch. They use kerosene—each holds enough for 9 to 15 hours of burning.

Install them now, before cold weather sets in; light them up whenever snow threatens and extinguish when weather is clear again (one man can take care of about 100 heaters); take them up and store them when spring finally arrives. They will be serviceable for years to come. Compared to manual snow removal, they will save each winter much more than their original cost plus operating expense. They will keep switches open in the coldest weather, the severest storms. Order now from any Bethlehem district office—don't wait until the first snow falls. Delay may be too expensive.

A Fuel opening, self-closing cap. May be filled while burning.

B Heat may be regulated as needed by shifting adjustable cover.

C Fuel capacity, 1½ gal. of kerosene—enough for 9 to 15 hours of burning.

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E Flange fits up against rail—protects ties from heat and regulates height of heater.

F Complete instructions on every heater.

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No. 94 of a series

Railway
Engineering and Maintenance

SIMMONS-BOARDMAN PUBLISHING COMPANY

105 WEST ADAMS ST.
CHICAGO, ILL.

Subject: DO YOU READ THE ADVERTISEMENTS?

September 30, 1936

Dear Reader:

Have you found the advertisements published in Railway Engineering and Maintenance helpful to you in the selection of materials or equipment? This query was included in a questionnaire that we sent 500 of you, selected at random, a few weeks ago. It was designed to develop the extent to which the efforts of alert manufacturers to serve you by presenting information regarding their products were meeting with success.

Your replies have been very interesting. Eighty-two per cent reported affirmatively, backing up their answers with references to specific advertisements. Only 10 per cent replied in the negative. Further analysis of the advertisements mentioned specifically shows that those advertisements "register" most effectively which describe specific uses or present definite facts regarding a product.

That the advertisements published in Railway Engineering and Maintenance constitute a distinct service to those who read this magazine is stated in numerous letters. Typical is the statement of one chief engineer that "I pick most of the equipment I want from advertisements, although I make an actual inspection before buying." From a somewhat different viewpoint, another system engineering officer wrote that he "finds it necessary to read the advertisements in order to have the 'goods' when asked for advice."

These replies support the contention that we have long held that alert railway officers are eager for information regarding products and equipment applicable to their needs. They also show that those manufacturers who seek to present constructive information regarding their products receive regular attention.

It is our hope that our advertising pages may command your attention equally with our editorial pages.

Yours sincerely,

Elmer T. Howson

ETH*JC

Editor

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- **Permits work to be carried on without interruption to traffic.**
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Railway Engineering and Maintenance

NAME REGISTERED U. S. PATENT OFFICE

October, 1936

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ELMER T. HOWSON
Editor

WALTER S. LACHER
Managing Editor

NEAL D. HOWARD
Eastern Editor

GEORGE E. BOYD
Associate Editor

M. H. DICK
Associate Editor

F. C. KOCH
Business Manager

Railway Engineering and Maintenance

The Test

Comes in Emergencies

WHAT is the measure of the value of the railroads to the local communities and to the nation? In part it is revealed by the character of the service they render the public from day to day—transporting food supplies with clock-like regularity, conveying raw materials into our factories and finished materials into our markets, selecting no traffic but accepting all traffic. It is revealed also by the payments made directly to railway employees, as well as indirectly to the employees of companies which produce materials and supplies used by the railways. It is likewise revealed by the taxes paid for the support of the schools and of the government, local, state and national. Yet these measures are so commonplace that they are seldom appreciated; as a rule they are taken for granted.

As a matter of fact, these values are commonly overlooked entirely when a new competitor enters the field. Public landing fields for airplanes, municipal docks for barge lines, and loading areas for buses in public streets are commonly provided free or at nominal rent, all reducing the expenses of operation of these agencies and aiding in attracting business from the railways which must provide at their own cost the terminal facilities which they need.

Emergencies Provide Test

It is only when an emergency arises that the real value of railway service comes home to the public. This was true last winter when large areas were swept by blizzards of unusual severity—storms that rendered highway transportation helpless for weeks, that grounded planes day after day, and forced hundreds of communities to depend on the railways—and on the railways alone—for the food and fuel necessary for their very existence. It was experiences such as these that brought to many communities a renewed appreciation of the value of the railways to them.

Now another emergency has arisen in a wide area of the plains states. Resulting from the protracted drouth, large areas are without sufficient feed for their livestock, necessitating the shipping in of feed or, more generally, the transportation of the stock to other areas where feed is available. By reason of crop failures, many of these communities are in desperate financial condition. Knowing these facts, the Department of Agriculture has turned to the railways with the request that they reduce their rates to permit the moving of feed into these areas and of livestock out.

Although the railways serving these areas are still suffering from the effects of the depression, and not a few of them are not earning their fixed charges, they have responded to this request as a measure of public necessity and without regard to the depletion of their own revenues, granting reductions of as much as one-third in rates on feeds and of 50 to 85 per cent in rates on livestock moving to available pastures. Through these measures, hundreds of thousands of head of livestock will be saved and at least a portion of their investment conserved by the farmers who take advantage of them.

Two Years Ago

That these measures are vital to the continued existence of the people in these stricken areas is evidenced by the record established under similar conditions two years ago. At that time, seven million head of cattle and five million head of sheep were moved from the drouth stricken areas of the west to southern states. This movement required 400,000 stock cars, sufficient to compose a train reaching from Los Angeles to New York.

This stock was all moved by rail. None was moved by truck. Nor were the trucks asked to reduce their rates as the railways did, even though they had been cutting more and more heavily into the regular livestock traffic of the railways for years.

There was a job to be done. It had to be done quickly. It had to be done cheaply. In the emergency the public turned to the railways then as it is now doing, as the only agency capable of meeting the emergency.

A Story To Be Told

The value of such a transportation agency should be evident to every thinking person. The necessity for preserving it should be equally evident. It is not merely or even primarily consideration for the railways that should prompt such action. It is individual self-interest.

Railway employees can well afford to see that all leaders of thought in their respective communities are aware of these facts in order that the necessary steps may be taken to insure the continuation of rail service to their communities so that this service may be available when the next emergency arises—whether it be by blizzard, drouth or flood.

The Roadmasters

Basis for the Value of Their Conventions

ANY organization that has survived the vicissitudes of 53 years, including two wars and two major panics, must possess some profound basic values, since it would otherwise have gone out of existence long ago. But if further proof of the merits of the Roadmasters' association is demanded it will be found on following pages of this issue. The caliber of the reports and addresses should be demonstration enough.

The value of the association to its members is not confined to the reports that its members turn out each year, for they have not always measured up to the standard that has been maintained during the last few years. Thus, in 1916—just 20 years ago—only three reports were presented, and these occupied only 9 pages of the annual proceedings, compared with some 40 pages for the reports that were prepared for the present convention. The performance in 1916 was perhaps not truly representative, but the comparison is at least indicative of the change that has taken place through the years.

There are, of course, good reasons why the reports read at conventions a generation ago seem inadequate if not superficial today. Track maintenance 20 years ago was just emerging from the status of a skilled craft, conducted according to methods developed through trial and error, and subjected to few influences that tended to make them obsolete. In these circumstances, the reports presented before the conventions of those years and the ensuing discussions dealt largely with established practices and variations in these practices as between different railways.

This situation no longer maintains. The labor scarcity brought about by the world war stimulated the use of power tools, and their introduction suggested changes in both procedure and organization. As a result it was not long before precedent had ceased to be a justification for any practice. Track men became more critical of the methods of the past and were encouraged by their managements to try out their ideas. This naturally had an influence on the work of the association; committee reports gradually came to reflect the new approach to current problems. Instead of confining their efforts to the recording of what was being done, the committees saw that they must show why it was being done in a particular way and present supporting data. This, obviously, led to more comprehensive reports of the type that have been presented at the conventions of recent years.

But this is only half the story. True, as brought out above, changing times have wrought great changes in the work of the association. But it is almost equally as true to say that times have changed because of the work of the association. By presenting a record of the new developments as they have taken place, by weighing these innovations in the light of the specific performance records, the association's committees have directed wide attention to the trends of the times. But perhaps of even greater importance has been the direct influence of the discussion of these reports on the floor of the convention. One effect has been the development of new facts not embraced in the reports, but more important than this is the influence exerted on those present—the stimulus to further experimentation along the lines suggested. And it is not too much to say that many of the methods now in general use have had their genesis in ideas suggested by these discussions. Nevertheless, the greatest benefit derived from participation in the work of the conventions lies in its psychological effect—in the instilling of renewed enthusiasm and the urge to think—to study old problems from a new angle. Every man who has ever taken anything to a Roadmasters' convention, even if it were only a desire to learn, has always taken much more home with him.

The Drought

Adequacy of Water Supplies Again Tested

FOR the third time in seven years drought conditions over wide areas have brought railway water supplies in many sections so near to the vanishing point that for weeks the situation has been critical, and in most instances there is no immediate prospect of improvement. In fact, in not a few cases, the situation is growing worse and the water-service forces are laboring under a serious handicap in their efforts to provide sufficient water to keep a gradually increasing traffic moving.

When the drought of 1930 put such a severe strain on the water resources of a large section of the country there was considerable discussion as to whether the expenditures necessary to forestall a water shortage under such extreme conditions could be justified. The general conclusion was that they could not, since such conditions are likely to occur only once in a lifetime, or even less frequently, while the interest on the investment and the cost of maintaining the increased facilities go on continuously. The drought of 1934, while it did not cover so great an area as that of 1930, was equally severe in many sections, thus weakening the argument concerning the frequency of occurrence.

Now that the roads are experiencing the third acute water shortage in seven years, that of 1936 being worse in some sections than either of the others, the question again arises as to what should be done. Should a road sit back and hope that it will not happen again, or should it take measures to prevent a water shortage if a similar deficiency in rainfall recurs?

These are questions that the railways themselves must answer; they cannot be answered for them. In fact, no road can give a general answer so far as its own situation is concerned, since every water station presents an individual problem that must be solved on its own merits, with due consideration for the local conditions and the needs of transportation. In some cases the problem is that of balancing cost against need; in others it is a question of availability and quality of the supply; while in still others it is largely a matter of overcoming engineering difficulties.

In the past, water development was based largely on apparent availability, little thought being given to rainfall records of previous years. Only recently has this matter been given consideration, and even today relatively

few existing supplies have been developed on this basis. For this reason, the severe water shortages of 1930, 1934 and 1936 emphasize the importance of making rainfall, stream flow, water stages in lakes and reservoirs, water table, quality as the deficiency in rainfall increases and other pertinent information a matter of permanent record. Regardless of the policy to be followed, future development cannot be placed on a sound engineering basis without this information. Now is the time to take steps to start the record.

Painting

What Has Been the Effect of Curtailment?

WHILE maintenance officers may be aware of the situation that has arisen on their own roads through cessation of painting, not many of them realize how widespread is the need for a resumption of this activity. During the last six years much has been said about track maintenance, changes in organization and adapting methods to get the most out of reduced appropriations, but practically nothing has been said about the maintenance of fixed structures or about painting.

In the effort to keep the tracks safe and in the best possible riding condition with the means available, other matters were given secondary consideration or ignored. Although most roads have done some painting since 1929, and a few reported that they have done considerable, for the country as a whole it can be said rather definitely that painting during this period fell into the second category, for, as one officer has expressed it, "we just stopped painting."

To determine the effect on railway structures of this curtailment of painting activities, a survey was undertaken in which 37 chief engineers and engineers maintenance of way assisted, the results of which are given in an article on succeeding pages of this issue. The information thus obtained is supplemented with photographs which give visual indication of conditions as they were found by members of our staff.

In studying the information which was given by these 37 officers, several things stand out prominently. In the first place, while they were unanimous in their assertions that their structures have not yet suffered deterioration from lack of paint, the photographs, which were not specially selected but represent average conditions on a number of roads, indicate that in many cases deterioration has already set in and that it is certain to occur on a large scale if painting activities are not resumed at once. In the second place, no question is raised as to the sincerity of these officers in making these statements. On the other hand, there are indications that some of them do not fully realize how seriously the curtailment of their painting programs has affected their structures, particularly since some of the photographs were taken on roads that reported their painting as only slightly in arrears.

It should be obvious that where paint is in the condition shown in the illustrations, and observation confirms that they do not over-emphasize the conditions on numerous roads, it is affording no protection to the structures. For this reason, in view of the enormous investment represented by the bridges and buildings maintained by the railways of the United States and Canada, it is evident that these roads may expect to suffer exceptionally heavy losses through deterioration of these structures, in fact, far more than the cost of painting, unless they take immediate measures to prevent this deterioration through a resumption of painting.

The Exhibit

A Service Institution of Great Value

THE history of American business will never be complete until some one has written the story of the merchandise exhibit, an institution that has become an established feature of almost all conventions that have even an indirect relation to business. Even teachers' conventions have their supply exhibits. Whether this development is ever made the subject of serious study, there is every reason to believe that the evolution of most exhibit associations has followed the general course of the Track Supply Association.

Representatives of supply manufacturers have gathered at the conventions of the Roadmasters' association almost since the first meeting. The reason is self evident —they could meet more of their customers for a smaller outlay for traveling expenses than was possible under any other circumstances. Furthermore, if some of them attended, the rest could not afford to stay away. While the underlying objective of the presence of supply men at conventions was an entirely legitimate one, the methods employed were not always above criticism, and at times were decidedly objectionable, and unfortunately, the innocent suffered with the guilty.

It was to correct these conditions that the Track Supply Association was formed more than a generation ago. Organized for the purpose of providing the means through which its members could have facilities for the presentation of their products to the best advantage, it has not only served them well, but it has rendered an equally valuable service to the members of the Roadmasters' association. In fact, the Track Supply Exhibit has become such an established adjunct of the conventions that no one now thinks of the convention without having the exhibit in mind as well.

While the exhibit is held concurrently with the convention, and has its justification from the standpoint of expense in the fact that a large number of members will be in attendance, it has been observed in recent years that its influence and its service to the railways is gradually extending beyond the limits of a strictly convention utility. Maintenance officers not directly identified with the association are visiting the exhibit in increasing numbers, some of them as members of committees of the American Railway Engineering Association and others individually. This in no way detracts from the cordial relationship that has been maintained between the Track Supply Association and the Roadmasters' association; rather it redounds to their mutual benefit. The Track Supply Association has established a creditable record. It is to be hoped that this record may be continued.

Paint Like This Has Outlived Its Usefulness—A Common Condition Today

How Far Behind

Survey discloses widespread curtailment required to restore con-

While it has been known in a general way that much painting has been deferred during the depression, there has been little realization of the extent to which painting programs have been curtailed since 1929. This article gives the results of a survey covering 60 per cent of the railway mileage of the United States and Canada. It discloses for the first time the present situation with reference to painting and discusses methods in vogue of purchasing and applying paint.

TO WHAT extent has painting been curtailed since 1929? To what degree have railway structures deteriorated for lack of paint? What expedients have been adopted to reduce the deterioration in structures that have not been painted recently? The importance of these questions becomes readily apparent when one considers that the railways of the United States and Canada are using and maintaining 370,000 buildings, ranging in size from the Grand Central Terminal in New York to the flagman's shanty at an outlying highway crossing; they are also maintaining 280,000 bridges. Furthermore, these structures represent an investment of $1,680,000,000 and $2,500,000,000, respectively, or a combined investment of $4,180,000,000.

Gains Poor Impression

As a further indication of the magnitude of these facilities, in normal times the railways spend annually $92,000,000 for the maintenance of buildings and $37,500,000 for the maintenance of bridges. These sums are exclusive of the cost of enlarging and improving existing buildings and of the construction of new buildings and new bridges.

In view of the magnitude of the investment in these structures and of the amounts involved in maintaining them, it is equally apparent that these questions concern every maintenance and executive officer, for during periods of retrenchment painting is the first maintenance activity to feel the effect of reduced appropriations. Likewise, this is the last activity to be resumed when conditions improve, since other classes of deferred maintenance are given preference because lack of painting does not affect the movement of traffic or the safety of trains. On the other hand, it is recognized that where deterioration occurs by reason of lack of paint, the condition is progressive and continues at a constantly increasing rate. It is worthy of note that, on the basis of the investment in these structures, an average deterioration of only one per cent in all of the structures maintained by the railways represents a loss of $41,800,000.

Railway buildings include more

than 100 different types and are used for a wide variety of purposes. Some, such as passenger stations, freight houses and offices, provide the facilities through which the public makes its principal contact with the railways. Others, which are used exclusively for railway purposes, such as section tool houses, company dwellings, water stations, interlocking towers, etc., are located in full view of passing trains. In either event, if these structures present a neglected or run-down appearance, the public gains a poor impression of the railway, which may be reflected in decreased patronage.

For these reasons, the majority of roads have customarily painted those buildings which are used by the public or stand within view from the track, more frequently than has been required for purely protective reasons. Only a small minority does not consider appearance to be of enough importance to warrant the more frequent painting that is required to maintain a high standard of appearance.

It is not debatable that, since 1929, painting has suffered more severely and for a longer time than ever before. It is fundamental that this state of affairs cannot be allowed to continue indefinitely without serious deterioration to the structures thus neglected. Furthermore, where deterioration gains a foothold, the resulting damage must be made up later by correspondingly increased maintenance appropriations.

With the knowledge that painting programs have been curtailed sharply in recent years and believing that information as to the present status of painting will be of interest to railway officers, a number of chief engineers and engineers maintenance of way have been asked how far they are behind in their painting programs and what has been the effect on their structures of the long-continued curtailment of their painting activities. Replies were received from 37 officers with jurisdiction over more than 168,000 miles of lines in every section of the United States and Canada, or approximately 60 per cent of the total mileage in these two countries.

Incidentally, one of the particularly interesting facts developed from these replies, which is confirmed by similar information obtained from independent sources, is that in normal times the railways as a whole spend approximately $9,500,000 annually for the purchase of the paint materials required to keep their fixed structures painted, this sum being exclusive of the cost of the labor for application. This amount includes not only the cost of the materials re-

Is Painting?

and the vast amount of work ditions to normal

These Structu Are Practica Devoid of P tection

quired for painting existing structures, but what is spent for painting new structures, those which have been enlarged or altered extensively, and for the painting done by contractors.

In view of the difference in point of view with respect to painting for appearance, it was not surprising that the view to maintaining a high standard of appearance. At the other extreme, a limited few said that appearance had never been a primary consideration, and that it had been their practice to do only such painting as was necessary to prevent deterioration in their structures.

Most of the roads indicated that, in the statements defining their practices and indicating the magnitude of their painting activities, the figures for individual roads varied between wide limits. Most of the officers indicated that it had been their normal practice to apply paint liberally, with as contrasted with buildings, the painting of bridges was based primarily on the prevention of corrosion. These facts should be kept in mind when considering the extent to which the painting of railway structures has been curtailed since 1929.

No Paint for Nine Years

Painting Greatly Reduced

As an example of the extent to which painting has been curtailed on those roads representing the majority viewpoint, the chief engineer of a western road which has been notable for the standard of appearance to which it has maintained its structures, reported that "our expenditures have been curtailed sharply since 1929 in the painting of stations, roadway signs, stock yards and wing fences. On the other hand, we have practically maintained our regular painting schedule for steel structures." Likewise, another western road of substantially similar standards of appearance reported that "since 1929, the painting of buildings has been curtailed at least 90 per cent, but we have not reduced by more than 10 per cent the painting of bridges, water tanks, signals, roadway signs, etc."

Still another western road of somewhat lower standards has, according to its chief engineer, "cut its painting by more than 80 per cent, including stations, bridges, water tanks, roadway signs, signals and other structures," while the chief engineer of a fourth road in the Middle West stated that "we just stopped painting buildings, but have fallen only a little behind on bridges; signs and signals are up to date."

Indicating that conditions are not greatly different in other sections, the chief engineer of a southern road stated that "we did not paint anything from 1930 to 1934, inclusive, but did a little more than half of our normal amount of bridge painting in 1935." The chief engineer of a second road in the South also reported that "we have done no painting whatever, except on steel structures, and then only as it became necessary to prevent deterioration." And a third stated that "we have kept our bridges up to date although we have done only about half of the normal amount of other painting."

Turning to the East, the engineer maintenance of way of another road which attaches considerable weight to appearance, stated that "we cut the painting of all structures 90 per cent," while another reported that "we have not curtailed the painting of steel bridges, tanks and signs, but have reduced the painting of buildings by half." In like vein, the chief engineers of two other eastern roads stated that they "have done no painting that could be avoided," although one of these reported that "some painting was done in 1935." Similarly, still another engineer maintenance of way replied that "our painting expenditures have been reduced considerably. We have done little painting of buildings, but have been watching our structures and doing such temporary or permanent painting as has been necessary to preserve them."

The engineer maintenance of way of still another larger eastern road stated that "we have not painted any buildings since 1929 and we cut our bridge painting by 95 per cent." "Because we abandoned a large number of buildings we were able to reduce our expenditures for painting this class of structures," said the engineer maintenance of way of another eastern road, "but the painting of bridges and other steel structures has been increased by about 30 per cent."

In contrast with the sharp reductions that were indicated by the foregoing roads, which attach great importance to appearance and strive to maintain a high standard in this respect, which were typical of the majority for both the United States and Canada, it is of interest to turn to those roads which represent the minority viewpoint with reference to appearance. In doing so we find that one road in the West, two in the South and one in the East, all of which do relatively little painting even in normal times, reported no reduction in expenditures during the period since 1929, while two of them reported an increase in their painting. The comment of the engineer maintenance of way of one of these latter roads was that "the painting of steel bridges, stations and other structures has been kept up during the depression. In fact, the paint on this road is in better condition today than it was 10 years ago."

"We have made no curtailment in our painting expenditures," and "we have kept our painting up to the same average that we have maintained since

1921," were the comments of the two southern roads, both of which reported that they had not reduced their expenditures for painting. A similar comment was made by the chief engineer of the eastern road in this group in his statement that "we have not changed our painting practices in recent years. As before 1930, we have endeavored to keep our structures so painted as to prevent deterioration, although in some cases recently, as previously, they have not looked as well as they might." Still another chief engineer of a road which has kept its painting to a high standard reported that "while we curtailed our painting by about 50 per cent from 1930 to 1932, in 1933, 1934 and 1935 we increased our expenditures enough to bring us back to normal at the end of 1935."

Deterioration Proceeds Rapidly When Painting Is Eliminated

A few roads that have always attached importance to appearance stated that while painting had not been done so liberally in recent years, the reductions have been slight. Typical of this group, the engineer maintenance of way of an eastern road stated that "no painting was deferred that might have resulted in deterioration of our structures. Where appearance was the only consideration we have deferred the painting temporarily, but at that we are not more than 10 per cent below normal." A somewhat similar comment was that of the chief engineer of a western road, who said that "while we have reduced our expenditures for painting steel tanks and like structures, we have not curtailed the painting of our steel bridges. Stucco is largely taking the place of paint on our buildings, and we are now in the midst of a stucco program."

This Building Has Little Protection Against Decay

Study of the statements from all of the roads, of which the foregoing are representative, with respect to the curtailment of expenditures for painting indicates (1) that, in general, there has been a sharp curtailment in the expenditures for painting since 1929, amounting in some cases to as much as 80 to 90 per cent, with a few instances of almost complete cessation of painting activities; (2) that on a few roads there was an initial curtailment but that the deficiency was made up by the end of 1935, while on a limited number of other roads, generally those of low standards, the painting is now ahead of 1929; (3) that on the majority of roads there has been as yet no attempt to catch up with the painting requirements, although in most cases the expenditures for 1936 have been somewhat greater than for any year since 1929; (4) that in many cases no buildings have been painted since 1929 and steel structures have received only such attention as was necessary to prevent deterioration of the metal.

Although these facts indicate quite clearly the general policies with respect to painting that were followed by the roads as their revenues declined and remained at a discouragingly low level, they do not provide a clear indication of the present status of railway painting. The reasons for this are, first, the wide diversity in painting practices prior to the onset of the depression and, second, the equally wide diversity in the methods that have been pursued during the depression years.

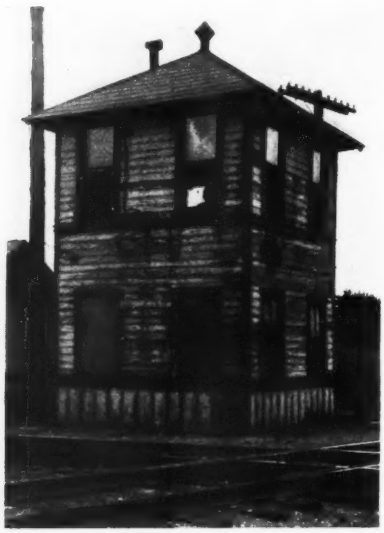
How Far Behind

For this reason, the officers to whom the queries were addressed were asked to state how far behind the painting programs are on their roads. Thirty-three officers gave estimates of how far they are behind, and as might have been expected in view of the wide variations in expenditures during the last six years, the replies covered an equally wide range.

Many of these estimates were considerably at variance with the statements concerning expenditures, however. For example, the chief engineer of a road that has done only 25 per cent of the usual amount of painting reported that the paint on all of his structures is normal. Another, who would ordinarily have spent approximately $1,000,000 on painting during the six-year period but actually spent only $180,000, stated that his painting is only 2½ years behind, instead of the 5 years that the cost figures indicate.

In general, these estimates indicated, as did the figures on the curtailment of expenditures, that in most cases where it was possible to do any painting the paint has been applied to bridges and other steel structures in preference to buildings. In a few instances the reports were definite

that the normal amount of painting had been done on steel bridges, and some of the others implied that this had been done. This matter will be discussed again later. The estimates, as given, of the present status of the



A Poor Advertisement for any Road

painting programs on the 33 roads in question are shown in the accompanying table.

While it is obvious that where a structure has been kept well painted, further painting can be deferred for a time without danger of deterioration in the structure, it is equally obvious that painting cannot be deferred indefinitely without deterioration setting in. It should be borne in mind, too, that in any normal painting program, the structures on a road always range from those that are freshly painted to others that are ready for repainting. For this reason, when painting activities cease suddenly, as they did at the end of 1929, deterioration will begin in the latter group first and almost immediately. It should not be overlooked, also, that on those roads which have done no painting since 1929, numerous structures have now gone without repainting for as many as 12 to 14 years.

Simply Stopped Painting

With these conditions in mind, inquiry was made as to what expedients had been adopted to reduce the deterioration of structures that would otherwise have resulted from the curtailment of painting programs. A wide variety of answers to this question were received. Not a few officers said frankly that they simply stopped painting and let it go at that. Others said that nothing had been done with respect to buildings but that they had done considerable spot painting on bridges. Still others had continued the spot painting until it became impracticable to do so longer, when they applied a single coat instead of the usual two coats. While it was not so stated directly, the implication was that this coat was customarily applied without the usual cleaning of the steel. As already mentioned, a few roads, five in number, have substantially continued their normal program of painting steel structures.

Obviously, although a bridge may not have been allowed to deteriorate, the fact that it has been prevented from doing so by resort to spot painting over an extended period, and in some cases by the eventual application of a single coat over the old paint, does not indicate that the paint is normal, although the structure itself may have remained so. It is scarcely conceivable that even the most optimistic would contend that if this practice were carried on indefinitely, the painting would be normal. One must, therefore, keep these facts in mind when considering how far behind painting programs are.

Little effort has apparently been made to prevent deterioration in buildings. One chief engineer said that some patch painting had been done wherever it became necessary to make repairs to buildings, but implied that this work had been done by the carpenter gangs making the repairs. Two others reported a limited amount of spot painting on sheet metal work, but nothing else in the way of protective work. A fourth explained that "stucco is now largely taking the place of paint on our buildings." With the few exceptions that have been mentioned previously, the remaining officers reported a practical cessation of painting work on buildings.

Buildings Retired

Railway buildings have a comparatively short life, as compared with other fields and industries. The reasons for this are that the demands of traffic are constantly changing and new methods of operation are being developed continually. As a result, buildings for which there is an imperative need today may be completely useless tomorrow. As an example, the development of long engine runs eliminated the need for numerous intermediate engine terminals and reduced the buildings at these points to obsolescence, although not a few were good for many years of service.

Bearing in mind the many changes in traffic and operating methods which resulted from the falling off of business due to the depression and competition from other forms of transportation, inquiry was made concerning the retirement of buildings and its effect on the painting activities of the individual roads. Thirteen officers reported that the retirement of buildings no longer needed had been an important policy on their roads during the last six years, and that this had been a real influence in minimizing the amount of painting that would otherwise have been deferred. While several roads have retired a relatively large number of buildings, in other cases the number has been negligible. In general, it was indicated that the buildings that were retired were relatively small and unimportant, although a few of considerable size were involved. The lists included section tool houses, section houses, pump houses, small

Deferred Painting Is Poor Economy

stations, miscellaneous shop buildings, several enginehouses, freight houses, warehouses, etc.

Returning now to further consideration of how far behind painting programs are, it is evident from their statements that not a few officers had in mind the condition of their structures rather than the status of their painting programs when they reported "normal." It is obvious that after six years of par-

tial or complete cessation of painting, the painting is behind even if the unpainted structures have not yet begun to deteriorate, and can scarcely be classed as normal.

Several roads which reported that they are not behind in their painting programs for steel structures, also said that during the last six years they have, wholly or in part, discontinued the painting of these structures and have been applying instead a protective coating containing a rust inhibitor.

Taken as a whole, therefore, one cannot escape the conviction that, although the statements of these officers are emphatic and unanimous that they have not allowed their structures to deteriorate for want of paint, the estimates that some have given of how far behind they are in their painting programs, are much too optimistic. This belief is strengthened by the fact that some of the estimates were predicated specifically on the assumption that by increasing sufficiently the appropriations for painting, the present deficiency can be wiped out completely in two or, at most, three years.

By reference to the table on page 610 it will be noted that the estimates given by the 33 officers who discussed this matter indicate that for the roads as a whole the painting of bridges is slightly less than two years in arrears and that buildings are not more than three years behind. However, on the basis of the actual expenditures for painting, as compared with normal years, and of the various expedients which have been adopted to prevent or reduce deterioration in steel structures, it can be said with a considerable degree of certainty that for the country as a whole, the painting of buildings is at least five years in arrears and that the painting of bridges is not less than four years behind.

This Road Is Six Years Behind in the Painting of Its Buildings

What Paints?

In the past, no subject has been more controversial than the selection of paints. Railway officers who had studied the subject and those whose knowledge was purely academic believed themselves equally qualified to pass on the materials and formulae for mixing paints. Both were equally suspicious of the manufacturer who offered them ready mixed paints. They classed as sales propaganda the suggestion that since the manufacture of paint was his business he knew more than they did about the composition of paints, or that he could furnish paint that would give satisfactory service under the special conditions of railway use.

In part, confidence in their own ability to specify paints was strengthened by the fact that many inferior paints were on the market for which the same claims were made as for those of superior quality. After a few unfortunate experiences with irresponsible manufacturers of paints the tendency was to condemn all prepared paints and return to specification paints.

Bearing these facts in mind, and as a matter of further interest, the officers to whom the inquiries were directed were asked to outline their normal painting practices, beginning with the selection of the paint and progressing to its application. Discussing the bases upon which paints are selected, five officers said that they select the paints separately, that is, they base their selections on different considerations for different types of structures, and also take into consideration the climatic conditions surrounding its use.

Five gave durability, and 12 previous experience with the particular paint under consideration as the important factors influencing their decision, while 5 stated that their paints are selected only after specific tests or service records have shown conclusively that they are dependable and suited for the purpose for which they are intended. On the other hand 7 officers depend entirely on the reputation of the manufacturer, while 2 gave suitability, durability and appearance as the prime requisites in making a selection. Most of the officers indicated that the ability to retain its color was an essential factor in making the selection, particularly for building paints. In several cases it was indicated that the basis for selecting bridge paint differs from that upon which building paints are selected.

Illustrating these practices specifically, the engineer maintenance of way of an eastern road stated that "we write our own specifications for paint for priming steel surfaces, to insure the highest grade materials; paints for finishing coats are selected on the results of previous use. We also have specifications for exterior building paints, but select interior paints, paints for signals, signs, etc., and all other paints on the basis of previous experience." Another engineer maintenance of way said that "our paints are generally selected on prior experience, although in a few cases tests are conducted, and the experience of other users is frequently given consideration."

An officer of one of the western roads stated that "all of our paints are selected on the basis of suitability for the purpose for which they are to be used, durability and appearance." A second officer reported that "we make our selection exclusively on the basis of tests." An interesting comment of a third engineer maintenance of way was that "all paint is bought from reliable

manufacturers who submit both bids and specifications. Annual inspections are made of the paint and if any manufacturer's paint does not stand up to the average performance, he is dropped from our list. We make no check to insure that the paint meets the specifications, but depend entirely on the results of its use."

"We are not interested in the formula used in preparing any paint. What we want is service, and our selections are based on this requirement and our experience," said the chief engineer of a southern road. In contrast, the chief engineer of a northern line takes the position that "we paint our bridges mostly with paints manufactured to our own specifications. This is by far the most satisfactory arrangement, because it cuts out the interminable arguments that otherwise arise as to the peculiar values of this or that brand of paint."

Manufacture of Paint

Manufacturing has always had a strange fascination for railway men, and in the past there was no field in which this was more apparent than in the preparation of paints. In fact, even in recent years, it was customary for the railways to buy the raw materials and grind and mix their own paints. It is common knowledge, however, that more recently many roads have discontinued the manufacture of paints, and to learn the extent to which this has been done, the officers to whom the queries were addressed were asked to state their present practice with reference to the manufacture of paint.

Without exception they replied that they are not now making paint, although several said that it is their custom to buy the paint in paste form and do their own mixing. The remainder, both those who buy on specification and those who depend on the manufacturer's reputation, stated that they buy their paints ready mixed. The reasons why they do not now make their own paint included "better results are obtained"; "the paint is of better quality and more uniform"; "we get a more uniform product at lower cost"; "we have no facilities for making paint"; "the manufacturer does a better job of grinding and mixing them than we could possibly do"; "there are comparatively few items that a railroad should manufacture, and I do not believe that paint is one of these products."

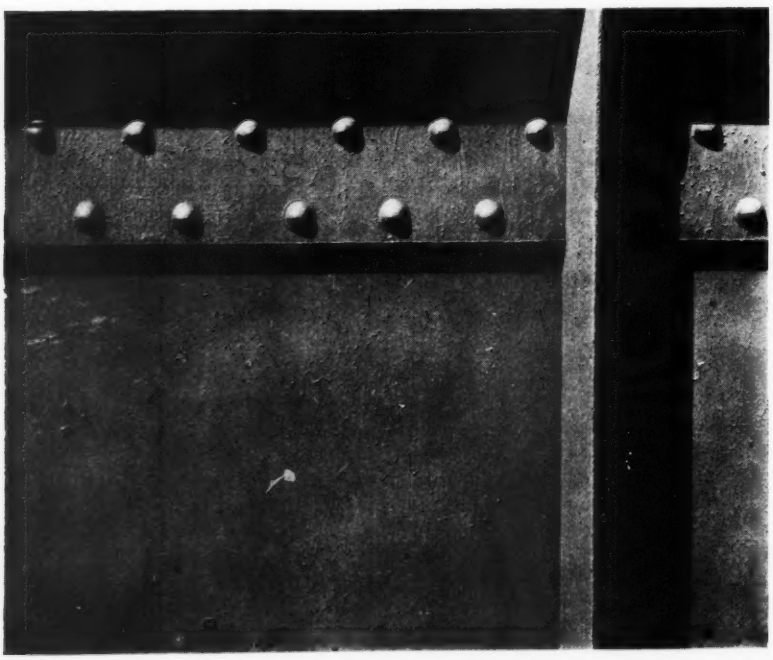
How They Buy

In view of the former attitude toward prepared paints, inquiry was made as to whether paint is now bought on brand or on specification. The answers to this question disclosed that there are interesting variations in the practices connected with the purchase of paint. Twelve officers stated that they buy on trade mark or brand, exclusively, relying on the manufacturer's reputation for the quality of the paint and that they have found this method most satisfactory. The reason for following this practice as given by one chief engineer was that "the manufacturer knows more about compounding paints than we do and is constantly in touch with new developments. Reliable manufacturers are willing to guarantee their products, whereas the responsibility for the performance of specification paints is our own, and it was not always what we hoped for when we were writing our own specifications."

Ten roads buy all of their paints in accordance with specifications, some of which follow the A.S.T.M. specifications or those of the government. In addition, one road which is now doing this is preparing to change its practice and buy on brand. The reason given for making the change is that "a reliable product cannot be assured unless the materials are tested and the process of manufacture is under constant inspection from start to finish, which does not add to the economy of the purchase."

Six roads reported that they buy both on brand and on specification, using the former for some purposes and the latter for others. Indicating a lack of consistency, however, certain roads buy trade-marked paint for buildings only, using specification paint for bridges and miscellaneous purposes, while others reverse this and apply brand paint on bridges and insist on specification paint for buildings. One chief engineer explained his practice by saying that he had been "unable to obtain paint of a uniformly true color when buying trade marked building paint." One engineer maintenance of way stated that while he buys on specification, "the terms are broad rather than detailed requirements for the ingredients, but they require the manufacturer to conform to a standard color card which is provided for him."

While none of the roads under discussion buy the dry pigments and other materials and do their own grinding and mixing, three reported that they buy the oil and the paint in paste form and to this extent do their own mixing. As a matter of fact, however, this is only another form of buying prepared paint. One



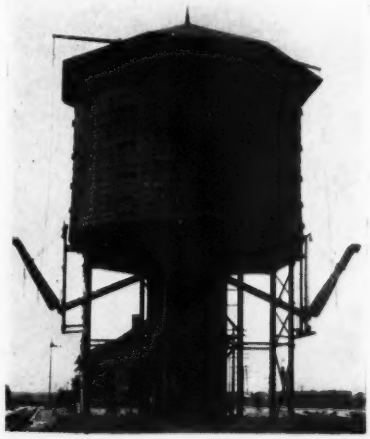
This Paint Film Is Beginning to Break

road buys both trade-marked paint ready mixed and paste paint, the latter comprising a considerable part of its requirements. More than half the roads reported that for special purposes they buy paste paint, but that this represents only a minor part of their consumption.

Getting Competition

Specifying certain brands of paint to the exclusion of all others obviously closes the door to competitive prices. To avoid this situation and to insure open competition with respect to both quality and price, all of the officers who are buying on brand stated that an approved list of several brands is prepared and the manufacturers of these paints are asked to submit bids.

In addition, a number of roads keep accurate records of the cost of both materials and the labor of application, as well as of the service life and other features of the different paints. From these records and from records of annual inspections, they are able not only to reduce the paints to an annual-cost basis, but



About 75 Per Cent of the Wood Is Exposed

are also able to judge whether the performance is satisfactory in other respects.

Those who buy on specification recognize the necessity for some check to insure that the specifications are being complied with. All except one of the officers in this group reported that the paint as prepared is given either a chemical analysis or some form of laboratory test. Only a few indicated that this is done with the raw matarials. One officer said that while laboratory tests are required, considerable dependence is placed on the reliability of the manufacturer. Only four require complete inspection of the manufacturing process, while two rely on occasional tests only and one road neither inspects the process nor tests the finished product.

A Poor Impression for Passengers

With three exceptions, none of the roads under consideration have any present intention of changing either their present methods of buying paint or the kind of paint they are now using. Among these exceptions, one road is changing its pigment for the purpose of returning to a former color standard, while the second plans to use a slightly darker shade of its present standard color "to give a better coverage, which we feel is necessary, owing to our lack of paint maintenance during recent years." The third, as already mentioned, which now buys on specification, is planning to change this practice and buy trade marked paints.

How Paint Is Applied

In answer to the question whether paint is applied by company forces or contractors, all but two indicated that for the most part, maintenance painting is done by company forces, but that larger jobs, such as large bridges, grain elevators, etc., and those requiring considerable staging are contracted. The reasons for this are that it is not economical for a railway to provide the equipment necessary for these larger jobs or to increase its force temporarily to take care of them. In most cases it was stated that the painting of new structures and those that are altered extensively is included in the general contract covering the work.

Among the reasons given for painting with company forces were that "it is more economical;" that "company forces do better work than the general run of contractors;" that "company foremen are familiar with the standards of railway painting and the conditions of operation, for which reason they are able to obtain greater uniformity in quality and appearance than individual contractors who lack this familiarity;" that "the responsibility of our own forces for the performance of the paint does not cease with the completion of the job, and they are inclined, therefore, to be more careful with their work;" and that "because most of the jobs of maintenance painting are small and widely scattered, a contractor can seldom compete in cost with the company gang, except on large jobs."

The engineer maintenance of way of a large road replied that his painting is done by both company forces and contract. The chief engineer of another road said that while it has been the practice heretofore to employ company forces in the manner already outlined, he is now experimenting with the contracting of local building painting.

"Prior to 1930," said the engineer maintenance of way of a third road, "all painting was done by company forces, but in order to make up the ground lost since that date, a considerable amount of painting is now being done under contract, with the

This Girder Is Deteriorating Rapidly Under Attack by Locomotive Gases

prospect that in the future a substantial amount of our painting, espcially of wooden structures, will be performed by contract painters."

Probably no class of engineers are more progressive than those engaged in railway maintenance. Yet there are times when they display an ultra-conservatism that is difficult to understand. One of the outstanding examples of this latter attitude is the method of applying paint. For years they resisted the introduction of spray painting into the maintenance field, although this method of application had been widely used with conspicuous economy by the mechanical department in connection with the construction and maintenance of cars.

As a result of this resistance, the application of paint to fixed structures by spraying made little headway prior to 1930. Since that date conditions have changed the viewpoint of many engineers, for which reason spray painting has come into considerable favor and there are definite indications that the use of spray painting equipment is on the increase.

This should not be interpreted to mean that it has received universal approval for those who have not adopted the spraying method can see no advantage in its use, and even among those who have done so there are differences of opinion as to the relative merits of brush and spray painting. As an example, a chief engineer reported that "we spray-paint our bridges where the type of structure and other conditions warrant, although this is combined with a certain amount of brushing. Our records indicate a saving of about 10 per cent in labor costs from the use of the spray machines, although there is a slight increase in the amount of paint used. We believe that the service life of the paint is equal to that applied by brushing."

"We do brush painting on only small isolated jobs and for trim work, or where the use of the machines may involve too much scaffolding," was the comment of the engineer maintenance of way of a large eastern road, adding that "the advantages are savings in time and labor cost, which far more than offset the small increase in the volume of paint used." "Spray painting can be done at less cost than brush work, which is the sole justification for using this method," expressed the attitude of the chief engineer of a road which applies most of its paint by spraying.

The foregoing comments are typical of those made by officers who believe that paint applied by spraying is no better than that applied by brushing. On the other hand, there is a group which believes that superior results are obtained from spray painting. This latter attitude was expressed by an engineer maintenance of way who said that "we do spray painting on almost all classes of work, and believe it to be superior to brush work in both quality and economy."

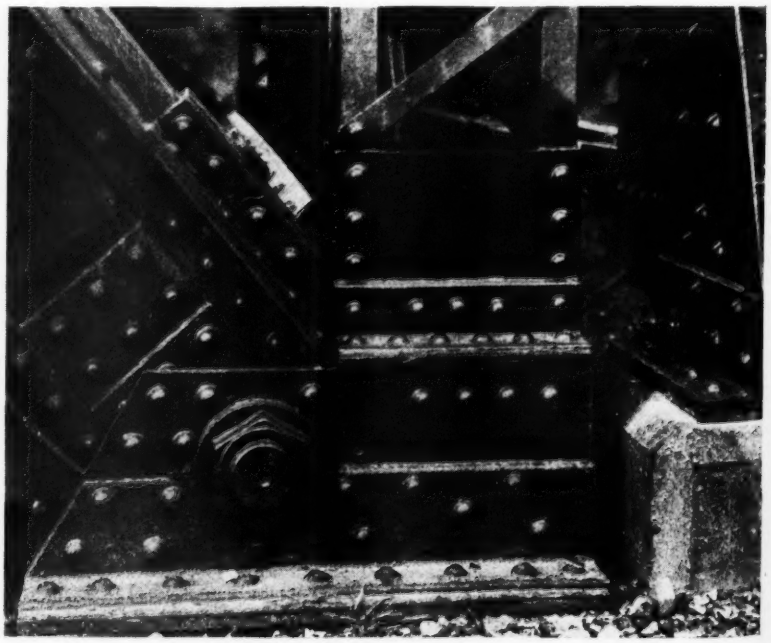
In contrast, another group says flatly that it prefers brush painting because it believes that a better quality of work is obtained from this method than from spray painting. A few in this group say, however, that while their experience has not yet convinced them that there are any advantages in spray painting, they are still open minded on the subject, and some of them are continuing to experiment with this method.

The information obtained from this survey indicates quite clearly that while necessity has compelled the curtailment of painting programs, engineering officers have been well aware of the deterioration in their structures, which is likely to result from this curtailment and have been alert to prevent or reduce it by any means at their command. While individual officers have been aware of the conditions on their own roads, the survey has disclosed for the first time the widespread curtailment of painting since 1929, and the vast amount of work which must be done on the roads as a whole to bring railway painting back to a normal basis.

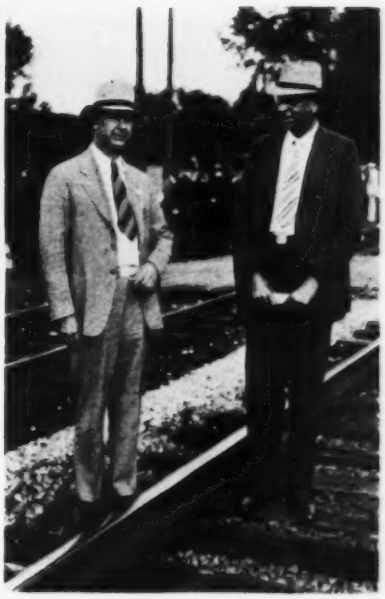
Present Status of the Painting Programs on 33 Roads

As reported by their officers

No. of Years behind	Bridges No. of roads	Buildings No. of roads
Better than normal	1	1
Normal	12	5
1	7	5
2	2	..
3	3	5
4	4	4
5	2	7
6	2	6



One-Coat Work Without Cleaning Is of Little Value



Above—The Roadmasters Took a Keen Interest in the Finished Rails Which They Saw Awaiting Loading at Gary. Right—President Chinn (left) and President-Elect Haley Discussing the Affairs of the Association.

Roadmasters

Hold Fifty-First Convention

Influence of high speed trains on track work, personnel problems, and better materials were among subjects discussed at meeting in Chicago

CARRYING out a carefully arranged program designed to meet routine as well as special current problems of the practical trackman, the Roadmasters and Maintenance of Way Association held its fifty-first annual convention on September 15-17 at the Hotel Stevens, Chicago, with a total attendance of 275 railway men.

An innovation introduced this year was the grouping of the committee reports and papers in such a way that the time of three whole sessions was devoted to specific problems of wide current interest. Thus, one session relating to organization and the human element in track maintenance included an address on "Building a Maintenance Organization" by W. F. Thiehoff, general manager (retired), Chicago, Burlington & Quincy; a committee report on the Selection and Training of Foremen; and an address by E. A. Meyer, chairman of the Safety Section, Association of American Railroads and manager safety and fuel departments, Chicago, Milwaukee, St. Paul & Pacific, on Taking Accidents Out of Trackwork.

Another session, concerned exclusively with materials, embraced a committee report on the Inspection of Rail; a paper by C. B. Bronson, inspecting engineer, New York Central, on Rail Maintenance, to be published in the November issue; and an address by John Foley, forester of the Pennsylvania, on Getting the Most From Crossties. Of the most popular interest was the third session set apart for a discussion of the problems of high-speed train operation, which included a committee report on Preparing and Maintaining Track for High-Speed Train Operation, and an address on Meeting Tomorrow's Requirements for Speed, by H. R. Clarke, engineer maintenance of way, Chicago, Burlington & Quincy.

Other features of the convention included a committee report on the Use of Work Equipment to Secure the Greatest Economy in Track Maintenance, as well as a committee report on Rail Lubrication. Greetings from railway managements were presented by A. N. Williams, president and general manager of the Chicago & Western Indiana and the Belt Railway of Chicago, while F. E. Morrow, vice-president of the American Railway Engineering Association and chief engineer of the Chicago & Western Indiana and the Belt Railway of Chicago, and T. H. Strate, president of the American Railway Bridge and Building Association and division engineer of the Chicago, Milwaukee, St. Paul & Pacific, offered greetings on behalf of the associations they represented.

On Thursday afternoon, 200 members and guests of the association visited the steel mills of the Carnegie-Illinois Steel Corporation at Gary, Ind., where opportunity was afforded to see the rolling of rails and the new normalizing process for removing initial stresses in rails. On Wednesday evening the roadmasters were guests at the annual dinner of the Track Supply Association, which organization also presented an instructive exhibit in a room adjoining the convention hall. Armstrong Chinn, chief engineer of the Alton and president of the association, presided over the convention.

B. E. Haley, general roadmaster of the Atlantic Coast Line, Lakeland, Fla., was elected president of the organization for the next year. Other

officers and directors were elected as follows: First Vice-President, W. O. Frame, assistant superintendent, C. B. & Q., Wymore, Neb.; second vice-president, A. H. Peterson, roadmaster, C.M. St. P. & P., Chicago; secretary, T. F. Donahoe, supervisor of road, B. & O., Pittsburgh, Pa. (re-elected); treasurer, E. E. Crowley, roadmaster, D. & H., Oneonta, N.Y. (re-elected). Directors to serve four years: R. L. Sims, district engineer maintenance of way, C.B. & Q., Galesburg, Ill., and E. P. Safford, supervisor, N.Y.C., Silver Creek, N.Y. Director to serve three years (to fill vacancy): Walter S. Lacher, managing editor, *Railway Engineering and Maintenance*.

Chicago was selected as the place for the next convention. The following topics were chosen for study and report at the next convention:

1—The maintenance of rail joints
2—The housing of track labor
3—The trackman's responsibility for the safety of highway crossings
4—The operation of motor cars to avoid accidents
5—Good practice in the laying of rail to secure workmanlike results.

President Chinn Emphasizes Responsibilities

AFTER reviewing the activities of the association during the last year, President Armstrong Chinn emphasized the opportunities presented to roadmasters and other supervisory maintenance officers to promote the interests of the railways through their contacts with the public. An abstract of his address follows:

For more than half a century, our association has advanced steadily toward its objective of raising the standard of work committed to the charge of its members. Many of the improvements in maintenance of way practices on our American railroads are the result of our committee studies and the deliberations at our annual meetings.

A review of our association activities since our last meeting is in order. I will begin with membership. If our association is to continue strong and virile, it must have new members and new thought. There are many men on our railroads who are not members but who ought to be. It is your job to help bring them in.

The financial condition of our association remains sound. If all members will pay their dues regularly and assist in bringing in new members, especially the young men now being promoted on most railroads, our finances will remain in a healthy condition and a small reserve can be accumulated for emergencies.

Every one realizes that the real work of our association centers around the committees. The membership was asked to volunteer for service on these committees because it was felt that so far as possible all who desired to take advantage of the opportunities offered by committee work should be given the privilege of serving. The result was most gratifying.

We are today entering a new era in transportation. As the tempo of life increases and man discovers more things to do, time becomes more valuable and it must be conserved in every way possible, especially the inactive time traveling from the completion of one task to the beginning of the next, and the dead time of money tied up in raw and finished products moving from origin to destination. Along with these demands for faster and better service, our railroads are faced with ever-increasing competition, some subsidized and others only partially regulated.

Armstrong Chinn
President

Mr. Chinn has been chief engineer of the Alton for seven years, prior to which he was in the maintenance of way department of the Burlington.

Meeting Competition

How can the railways meet this competition? The answer seems to be in two parts. First, the railways must offer the public the kind of service it wants at a price it is willing to pay. Second, those interested in the welfare of the railroads, particularly railroad employees, should learn of the many benefits to the public that come from railroad transportation and then use every reasonable opportunity to inform the public and prospective patrons of these benefits. When the people realize what the railroads are doing to give them satisfactory service and know of the many benefits that come to every community with railroad transportation, they will not only be sympathetic toward the railroads, but will actively support them as valuable assets.

What are the railroads doing to give better service? The answer is well known. Constantly, engineers are bending their efforts towards perfecting safer, faster and more comfortable equipment, while maintenance of way men are improving and refining track structures so they will carry this finer equipment on its faster schedules with the safety and comfort for which it was designed. The success of these efforts is amply demonstrated by the many types of high speed passenger trains that are now in operation all over the country.

The improvements in freight service, while not so spectacular, have also been substantial and are of considerable value to shippers. Freight may now be picked up and delivered at the shipper's door and is now carried in trains that move on schedules that compare favorably in speed and regularity with passenger service. This, however, is just the beginning.

New types of power, new types of equipment and new types of service will be developed and used as they are perfected to the stage where they become economically justified.

What are the benefits of railroad transportation to the public about which a railroad man may speak with pride? There are so many that it is difficult to know where to begin. To start with, the railroads,

outside of agriculture, represent the largest, most valuable and widespread industry in the country. They have 243,000 miles of lines, with 402,000 miles of tracks, extending to every part of the nation. There has been invested in all those facilities that go to make up the railroads, the tremendous sum of 25 billion dollars, or approximately two hundred dollars for every man, woman and child in the country. This huge investment is not concentrated in the hands of a few, but is owned by banks, insurance companies, schools, churches and a great number of individuals. Therefore, every one who has a share of railroad stock, a railroad bond, a bank account or an insurance policy, has a direct financial interest in the railroads and in their success.

As industrial employers the railroads rank among the largest in the country. They have on their payrolls, during normal times, more than 1,500,000 people. These employees are paid annually more than $2,500,000,000. This immense payroll is distributed over the entire country wherever there is a railroad line. Every station agent, every section man and every trainman gets a part of it. These employees spend this money with the merchants in their communities. The railroad employees of the nation have a tremendous purchasing power.

In addition to the payrolls, the railroads contribute to the communities that they serve through the payment of taxes. Last year they paid a total tax bill of more than $236,000,000, and taxes are going up. An analysis shows that railroad taxes are divided among the various governments and agencies about as follows: States 8 per cent, counties 15 per cent, townships 1 per cent, cities, towns and villages 13 per cent, roads 15 per cent, schools 46 per cent, and miscellaneous 2 per cent. The importance of the part played by the railroads in the education of the youth of the nation is clearly shown by these figures. It is difficult to imagine what many communities would do for schools if it were not for the railroad taxes that support them.

Heavy Purchasers

The financial benefits received from the railroads by local communities do not end with payrolls and taxes. There is a third and very valuable way in which the railroads contribute directly to the prosperity of the communities that they serve. Furthermore, the railroads have a vast plant of tracks, buildings, machinery, rolling stock and other facilities that is constantly wearing out. To keep this plant running efficiently, great quantities of materials are needed for maintenance and repairs. Then, in the actual operation of the railroads, additional quantities of materials are needed, such as coal and oil for locomotives, food for dining cars, stationery for offices, gasoline for motor cars, electricity for power and light and many other items. Finally, the railroads are always making improvements, adding new facilities and new equipment, for which new materials and supplies are required.

Furthermore, the railroads buy prodigious quantities of materials for maintenance, for operation and for improvements. They buy about 23 per cent of the coal, 19 per cent of the fuel oil, 20 per cent of the timber and 17 per cent of the iron and steel produced in the nation. It takes many industries and many workers to keep the railroads supplied with these materials and railway purchases are, therefore, responsible for creating much local employment and supporting many local payrolls outside of the railroad industry itself. In normal times annual railway purchases run well over $1,000,000,000. At present they amount to about $600,000,000 a year.

Any community that is to grow and develop must have transportation, good transportation that reaches every point in the nation, transportation that can be relied upon to function at all times and under all conditions. With the railroads, reliability and dependability are watchwords of their service. Last winter when conditions were particularly severe, when rivers and lakes were covered with ice, when

B. E. Haley
First Vice-President

W. O. Frame
Second Vice-President

T. F. Donahoe
Secretary

E. E. Crowley
Treasurer

C. A. Lichty
Assistant Secretary

Roadmasters' Association

Officers 1935-1936

Armstrong Chinn, President, Chief Engineer, Alton, Chicago.

B. E. Haley, First Vice-President, General Roadmaster, A.C.L., Lakeland, Fla.

W. O. Frame, Second Vice-President, Assistant Superintendent, C.B. & Q., Wymore, Neb.

T. F. Donahoe, Secretary, Supervisor of Road, B. & O., Pittsburgh, Pa.

C. A. Lichty, Assistant Secretary, Chicago.

E. E. Crowley, Treasurer, Roadmaster, D. & H., Oneonta, N.Y.

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(Terms Expire September, 1939)

R. H. Carter, Supervisor, Illinois Central, Chicago.

A. H. Peterson, Roadmaster, C.M.St.P. & P., Chicago.

(Terms Expire September, 1938)

J. J. Clutz, Supervisor, Penna., Trenton, N.J.

F. B. LaFleur, Roadmaster, S.P., Lafayette, La.

(Terms Expire September, 1937)

W. H. Sparks, General Inspector of Track, C. & O., Russell, Ky.

B. Esbenson, General Roadmaster, U.P., Milford, Utah.

(Terms Expire September, 1936)

G. T. Donahue, Supervisor, N.Y.C., New York, N.Y.

W. C. Pruett, Assistant General Foreman, M. of W., M-K-T., Muskogee, Okla.

highways were blocked with impassable drifts, when the air was full of snow and sleet and fog, when all other forms of transportation were at a standstill, the railroads kept their lines open and their trains moving. This fact was recognized by the public.

Speed with Safety

The railroads offer the safest and most comfortable transportation available. They also offer speed, but speed with safety. The speeds at which railway trains operate today were unheard of a few years ago and have brought to the United States the railway speed crown of the world. When slow orders are written, as they now are, that require trains to reduce speed to 90 miles per hour, we know that the day of speed has finally arrived.

The comfort of railroad travel is unexcelled. New types of passenger equipment have been provided with more comfortable seats, better lighting, more attractive decorations and new facilities. Counter cars, lunchroom cars, tavern cars and luxurious lounge cars are found in most trains. Probably the greatest boon of all to travelers is air conditioned passenger equipment. In providing comfort for passengers, maintenance of way men have not overlooked the track. Curves have been relined, spirals lengthened, and alinement and surface generally refined to give passengers a smooth ride with as little sensation of motion as possible.

Perhaps the proudest boast of the American railroads is their unparalleled record for safety. During 1935, while motor vehicles were killing 36,400 people on the highways, the railroads transported nearly 500,000,000 passengers without a single fatality in a train accident.

What other form of transportation can offer the people of the nation the advantages and the benefits that they receive from the railroads? In national value, in payrolls, in taxes paid, in materials purchased, in reliability of service and in safety the railroads stand far out in front of any other transportation agency. As railroad employees we have every reason to take pride in the industry we serve, to take pride in the part we have in that industry and to take pride in the story we are in a position to tell of its achievements.

The Railways Forge Ahead

By A. N. WILLIAMS
President and General Manager,
Chicago & Western Indiana and Belt Railway of Chicago

LOOKING over the last seven years and reviewing the changes that have occurred in the railroad industry during that time, it is evident that the policy adopted by the responsible officers and directors of the railroads of this country, of plowing back into these properties a considerable proportion of their earnings during the period from 1920 to 1929, has been fully justified.

An industry that has suffered a maximum shrinkage of more than 50 per cent in gross revenues, has faced droughts, high water and bad snow conditions, loss of export traffic, dislocation of industries and other serious problems, and whose usual reservoirs of credit were closed; yet has been able to increase the speed of both freight and passenger trains, render better service than ever before, and maintain the highest safety record of any time in its history, is not an industry asleep as charged by some of the advocates of government ownership, but a vigorous, resilient industry able to cope with adversity and to accomplish results in the face of unprecedented difficulties.

The speeding up of freight trains, while not generally advertised, is a tremendous factor in the service of these railroads, which has worked out to the benefit of the shippers, both in dependability and in decrease in time of goods and materials in transit. At the same time, the business has been handled a great deal better than it has ever been handled before. This is reflected in lower claim payments.

The introduction of high-speed steam trains has gone a long ways to recapture the good will of the American people. We who have been in close contact with this movement know what has been required in higher standards of maintenance for these high-speed units. Track surface and line have had to be refined, spirals lengthened, signals respaced, track circuits re-arranged, track inspection intensified, and a considerable additional load placed on maintenance of way and equipment forces.

Little did we realize in the nineteen twenties, when we were spending a great deal of money for reconditioning tracks, widening banks, improving drainage conditions, installing new and strengthening existing ballast, laying heavier rail, installing rail anchors, manganese frogs, switch points, heavier joints, etc., that we would so soon be called upon to demonstrate the wise decision made when this money was spent. Many of these jobs such as permanent bridges, permanent culverts, drainage, bank widening, and ditching have paid big dividends for the money expended, and there is no question but that the American railroads as a whole are in better shape physically than they were 15 years ago.

While all of the railroad employees have had a hand in this, there is no one department that has contributed more in the way of loyalty, sacrifice and hard work than the maintenance of way department. It was largely your job to figure out ways and means to accomplish the result when the necessity was called to your attention.

Looking into the future, we find a changing picture ahead of us. Referring particularly to the maintenance of way department we are today forced to modernize our methods. This means we must mechanize our steel gangs, providing them with power adzers, power drills, power spike drivers, etc. It is almost impossible to tamp ballast satisfactorily today to withstand the impact of high speeds and heavy power without power tools. Present-day high speed freight and passenger trains make it absolutely necessary to give a different class of supervision than was formerly required.

A new note has been sounded by the railroads in the advertising and publicity activities of the Association of American Railroads. This has found an echo in the individual railroads. One of the most important jobs that we, as railroad employees, have, is to realize that the public should not be expected to take speed, comfort and safety for granted, but attention should be called continuously by railroad employees and their friends to

these results, to the end that our relation with the public will be better, and that the railroad employees will be given credit for accomplishing a splendid piece of work. Remember that every citizen with whom you come in contact is a prospective juror and may be called upon to decide a lawsuit which may vitally affect the whole industry, and especially, your company. They should be able to approach their jury duties in an unbiased frame of mind, not warped by some real or fancied grievance against a railroad due to some unfortunate experience at the hands of a railroad employee.

Maintenance of way officers should be on the alert to call the attention of their division and other officers to changes in their territory. These changes cover new industries, new materials, new sources of supply for old materials, new potential passengers, and other factors which directly affect our well-being and the well-being of the industries that support us.

With the new method of operation, it is incumbent upon supervisory officers of the maintenance of way department to take on increased responsibilities with respect to selecting and training employees for future positions. Nothing demonstrates a supervisor's ability more than to be continuously supplied with material from which foremen and supervisors can be made and to have such material ready and at hand when the necessity arises.

We must not fool ourselves; the battle is not yet over. We are just beginning to emerge from this depression, and we are emerging into a changed world. We must operate these railroads in the future at the same or lower rates for freight and passenger service; we must give increased, better and more dependable service than at present; we must meet further competition of such subsidized agencies as trucks, buses, airplanes and waterways. The era of extensive physical development of these railroads is past; our problem in the future will be one of intensified development of a better plant than we now have, increasing its efficiency of operation, co-ordinating and integrating the activities of the present plant with other forms of transportation, and the co-ordination of terminal and other classes of railroad facilities and services.

Selecting and Training Track Foremen

Report of Committee

TWO excellent committee reports on this subject have already been presented before this association. The first report was presented at the forty-first annual convention in 1923, and the second report at the forty-seventh annual convention in 1929. However, the subject has again become a pertinent one. We are emerging from a depression with ranks depleted by necessary retrenchments, and are confronted with the problem of an insufficient supply of suitable and adequately trained trackmen from which to fill vacancies among our foremen.

We are also confronted with new methods of maintenance, due largely to the ever-increasing importance of labor-saving equipment in our maintenance work. For the most efficient utilization of this equipment, specialized gangs are being developed, and our system of selecting and training foremen must be revised in the light of this development.

Your committee is convinced that satisfactory results in the selecting and training of foremen can only be obtained through a systematic procedure, effectively applied, for hiring new men, training and advancing them to the position of foremen, and subsequently continuing their training and education.

Hiring New Men

The importance of hiring good men merits most careful attention. There are certain fundamental and basic qualities or characteristics of a man that are the result of breeding and upbringing and these cannot be altered by later training. Psychologists generally recognize that intelligence is an inherited characteristic. They also agree in general that many, if not most, of the traits of the individual's personality are developed in the formative period of early youth. Physical strength and resistance to certain diseases are to some extent hereditary. We have much to learn concerning the development of a practical system whereby the characteristics of men may be determined so they may be placed in the position for which they are best fitted. Where it may be applied in a practicable manner, a system of intelligence tests is recommended for determining the fundamental characteristics in prospective foremen.

Among the somewhat abstract, but nevertheless important, fundamental characteristics that should be required are good moral character and attractive personality. This does not imply that an over-pious behavior or an exceptionally smiling countenance are necessary, but it is important that the prospective employee have a sound sense of honesty and justice, and the ability to associate pleasantly with fellow workers and the public. The ability to associate pleasantly with the public is especially important in foremen because in many instances they constitute the sole source of contact between the railway company and the public.

Since track maintenance is outdoor work involving exposure to the elements, particularly in times of emergency, a rugged physical constitution is a necessity. Because of the dangers associated with track work, good vision and hearing are also fundamental requirements. Physical examinations should be employed to determine whether recruits have the necessary requirements in these respects.

Education has contributed to a major extent to our present ability to produce the necessities and luxuries of life and should be without question an important attribute in new recruits. If at all possible, a high school education or its equivalent, should be considered a fundamental requirement for new employees.

Inducements

The extent to which new men having desirable characteristics may be drawn into railway service, depends upon the inducements offered them. The worth of these inducements should be clearly realized by supervisors and foremen. The most important considerations to a workman are steady employment, good wages, suitable living conditions, efficient supervision, and opportunity for advancement.

This association has in the past gone on record as favoring the employment of a small maintenance force the year around. Where this is done, steady employment may be offered the most desirable workmen to hold them in the company's service.

Wages paid track laborers are usually adjusted to correspond with wages being paid for similar service in other industries. Pass privileges are

in effect an addition to wages, and their value as an inducement in attracting workmen should not be overlooked. Insurance and hospital benefits and pension systems have generally been put into effect on railways and these have a substantial value as social security benefits.

Unfortunately, owing to the transitory nature of the work, the living conditions afforded in railway service are in general not entirely satisfactory. Much attention has been, and should continue to be, directed towards improvements in this particular. Section headquarters should be located with a view to affording comfortable and sanitary living conditions and the best public school facilities that may be available. For floating or specialized gangs, suitable outfit cars with comfortable and sanitary living facilities and well prepared food are well worth their cost.

This association is an effective agency in improving the efficiency of supervision. Efficient supervision is a term having broad implications. It embraces, in addition to adequate direction of the various items of maintenance work, responsibility for the welfare of the workmen, interest in them and their problems, fair treatment and the just exercise of discipline—all of which tend to promote contentment and good morale within the organization.

Opportunity for advancement and the incentive which it affords workmen for improving their work form the basis for the prosperity of our country. To provide incentive for workmen, it is recommended that new foremen be selected from the trained ranks of the laborers, and the supervisors from the trained ranks of the foremen. It is also recommended that a differential in pay be established for laborers, giving recognition to their ability and the length of their service in the organization. This affords a particularly valuable inducement because it will appeal especially to men who possess the characteristics that are desired.

Training Men

Laborers must be trained in such a manner as to provide an adequate supply of competent men from which new foremen may be selected when required. This training must be done primarily by the section foremen. In his daily contact with the laborers, it is his duty to train and teach each man how to work safely and efficiently and according to the adopted standards.

A good foreman will arrange his organization so that a new man will have an experienced trackman as a partner, thereby making it possible for him to grasp the details of the work more readily. In addition, such a foreman will watch the new man closely and instruct him when necessary concerning the proper methods of performing work and the safe use of tools.

It is especially important that the foreman drill the new man in safety rules, particularly the flagging rules. This should be done when the man is first put to work, and repeated at least twice at later intervals after he has become more familiar with track work and railroading in general and will, as a consequence, be better able to grasp the significance of each rule. The importance of maintaining the track in a condition safe for high-speed train movements must be emphasized, attention being given to the proper handling of switches, the use of tools, the replacing of track materials, and flag protection in the event of obstructions. The new man must understand thoroughly that train enginemen assume the track is clear for high speed operation and depend on the trackmen to tell them otherwise, either by proper flag protection, or by order, if an obstruction exists.

By the time a new man has been employed for several months, the foreman will have had an opportunity to observe whether he has a sense of loyalty to the company and the organization. Loyalty is a requisite which cannot be too strongly emphasized. Maintenance of way men have long been known as the most loyal of railway employees; this is a reputation of which we should be justly proud, and which we should maintain.

Each foreman should have at least one man in his organization who is capable of handling a foreman's position if the occasion should arise. In this manner a supply of trained men is created from which vacancies among the foremen may be filled.

A system of apprenticeship is recommended for laborers showing exceptional promise of making good foremen. This should include a four-year period comprising full experience in all branches of track work, instruction in methods of preparing daily report forms and accounts, and experience in handling men in a capacity similar to that of an assistant foreman. A differential in the rate of pay should be provided as compensation for the added effort and responsibility that is required.

Selecting Foremen

Foremen should be promoted from laborers or apprentices, selecting them from this available supply of trained men in accordance with their ability, and with some consideration to their seniority. To insure that the men are sufficiently instructed in safety and flagging rules, and in the uniform practices of trackwork employed by the company, a written and oral examination should be administered. The track supervisor and division engineer, or superintendent, should have the final decision in the selection of the foremen, and should be influenced in their decision by the results of examinations, due consideration being given to the seniority and the physical and moral characteristics of the men. Seniority deserves some weight, but should not be made too important as a factor in determining the selection of foremen. Advancement solely upon the basis of seniority indicates a lack of courage or good judgment by the track or division supervisors.

A systematic and fair method of promotion is necessary for good morale in the organization. Impartiality must be maintained in making advancements, which must be judged on merit and ability alone. To allow political, religious, family or other affiliations to have an influence in making promotions will play havoc with the morale of the organization.

Training Foremen

Following the advancement of a laborer or apprentice to foreman, he should participate in a general plan for training foremen. This training should be a continuous process. Some form of maintenance of way meetings should be employed to provide the means for this training.

In these meetings, which should be held at regular intervals, foremen should be thoroughly instructed in uniform practices of performing work, and open discussions of possible improvements in the uniform practices should be held. Whenever improvements are suggested, the decision should rest with the maintenance officers as to whether they should be adopted as uniform practice. This is especially important. It is only in this manner that the full benefit of the better judgment and perspective of the maintenance officer, the experience and views of the foremen, and the specialized knowledge of staff experts can be obtained.

The meetings should be presided over by the proper maintenance officer. The selection of items of work to be studied should generally correspond with the type of seasonal work to be done following the meeting. Two or more foremen should be asked to prepare papers on the items of work to be studied, selecting men for this work who appear to be the best informed on the subject. The

papers should be read at one of the meetings and followed by a thorough discussion of the subject. The decision as to what changes, if any, are to be made in the uniform practices as a result of the study should be made by the presiding officer. Meetings should be conducted informally and in a friendly spirit. Under no circumstances should these meetings be used as an opportunity unduly to criticize those present for their shortcomings.

The study of current magazines and books dealing with railway maintenance, and the taking of correspondence courses in railway maintenance, are of value in broadening the education of the foreman. However, it should be understood that railway maintenance officers are responsible for the safe maintenance of the property, and methods and ideas gained by reading and study are not to be adopted by any foreman for use until they have been thoroughly discussed at the meetings and approved as uniform practice by the responsible maintenance officer.

Discipline

A fair and just system of discipline is necessary to the maintenance of an efficient organization, but the matter of discipline may be best handled by instilling in the men an interest and enthusiasm for their work. Where this is done, and where the men have been properly selected and trained and have a clear and complete understanding of uniform practices, little discipline will be required.

It is important, however, that when it is clearly indicated that a mistake has been made in selecting men for the organization, it should be immediately corrected. Should a new workman prove to be intractable, incompetent, or of anti-social inclinations he should not be retained in service. The interests of the company, his fellow workmen, and himself are best served by a prompt discharge of this supervisory obligation.

Changes in Methods

With the increasing development of labor-saving machinery for maintenance of way work, new positions are being developed for foremen and operators. These new positions, wherever possible, should be filled by promotion from the ranks of laborers, apprentices or foremen. In order that an adequate supply of well trained men will also be available for these positions, the application of the plan for the selection and training of foremen previously described should be so broadened as to provide for the increased demand.

Conclusions

The committee presents for your consideration the following conclusions:

1. In selecting new men for the year-around or permanent maintenance force, close attention should be given to securing men whose mental, physical and moral characteristics make them suitable for development into foremen.

2. Sufficient inducements should be provided to attract desirable men into the service.

3. Emphasis should be placed upon the need for adequate training of laborers by foremen in rules of safety and uniform maintenance practices.

4. Foremen should be advanced from well-trained laborers or apprentices after passing suitable examinations on safety and uniform practices, with due regard to loyalty and mental, physical and moral characteristics, and with proper consideration of seniority.

Emphasis Should Be Placed on Adequate Training

5. All foremen should be trained continuously in safe and uniform practices for performing maintenance work.

6. New positions of foremen and operators for specialized gangs should, wherever practical, be filled from trained laborers and apprentices.

Committee—G. T. Anderson, (chairman), roadmaster, K.C.S., Pittsburg, Kan.; L. M. Denney, (vice chairman), supervisor track, C.C.C. & St. L., Indianapolis, Ind.; T. N. Turner, roadmaster, M.P. Newport, Ark.; A. T. Darnell, roadmaster, G.C. & S.F., Ft. Worth, Tex.; R. D. Copeland, roadmaster, Ann Arbor, Owosso, Mich.; C. T. Mulcahy, roadmaster, Southern Pacific, Niland, Cal.; J. A. Spurlock, roadmaster, M-K-T., Muskogee, Okla.; J. C. Runyon, supervisor of track, C. & O., Covington, Ky.; W. T. Eldridge, supervisor, I.C., Vicksburg, Miss.; E. J. Brown, roadmaster, C.B. & Q., Chicago; A. R. Jones, division engineer, N.Y.C., Albany, N.Y.; C. H. Higgins, assistant division engineer, B. & M., Dover, N.H.; H. L. Barr, assistant engineer, C. & N.W., Huron, S.D.; J. J. Clutz, supervisor, Penna., Trenton, N.J.; G. B. Hickok, roadmaster, P. & S.F., Slaton, Tex.; J. M. Murphy, roadmaster, C.M. & St. P. & P., Sioux Falls, S.D.; R. E. Meyer, roadmaster, C. & N.W., Wall Lake, Iowa; M. Donahoe, division engineer, Alton, Bloomington, Ill.; E. J. Ryan, track supervisor, D. & H., Port Henry, N.Y.; W. H. Haggerty, supervisor, N.Y., N.H., & H., Harlem River, N.Y.

Discussion

In answer to a question by F. B. LaFleur (S.P.), Chairman Anderson stated that his road had not employed student foremen, but that the committee believed that the idea of student foremen had considerable merit. President Chinn called attention to the fact that some roads, like the Alton, employed assistant foremen for extra gangs and yard gangs, and that these positions were not unlike those of student foremen in that the men were being trained for the position of foreman.

Mr. LaFleur stated that the Southern Pacific, Texas and Louisiana lines, which generally employs negroes for track labor, recruited white men for training as foremen, selecting men who appear to have the requisite qualifications. After these men have been employed in the gangs for about a year, their wages are increased from 2½ to 5 cents above the standard rates for laborers, and as soon as they indicate that they have developed sufficiently, they are employed as relief foremen.

B. E. Haley (A.C.L.) questioned the committee's statement that a man should receive four years' training before he is promoted to foreman. The practice on his road, he said, is similar to that reported by Mr. LaFleur in that most of the laborers are colored and the foremen are white in all cases. It is his experience that white men selected for training as foremen, if they are given a sufficient variety of experience, will frequently qualify in considerably less than four years. However, it is his observation that the training should not be discontinued when the man has been promoted, since some men do not seem to appreciate the problems involved until they are given complete responsibility. He added that too often a man seems to think that "school is out" after promotion.

Mr. Haley's view was endorsed by S. W. Brady (G.C.&S.F.) who declared that no definite period should be specified, reporting that in some cases coming under his observation, men have been appointed roadmasters within four years after they entered track service.

E. E. Crowley (D. & H.) questioned the advisability of a differential in the rate of pay of trackmen. It is his observation that where it is the practice to advance the rate of pay after a given period of service, many of the men receiving the higher rate will not be as efficient workmen as

younger men with a shorter service record that does not entitle them to the higher rate. On the other hand, William Shea (C.M. St. P. & P.) favored the higher rate for men of longer service, citing the experience of the Milwaukee, which pays a higher rate to men who have worked a number of hours equivalent to about two working seasons' employment. This higher rate, he said, offered an inducement for experienced men to return to the section gangs after having been laid off during the winter months.

In the opinion of Mr. Haley, much of the discussion was based on experiences throughout a protracted period of labor surplus, and he contended that it would be necessary to approach the problem from a different point of view when the railways are confronted with a scarcity of track labor. President Chinn called attention to the fact that men in training for foremen sometimes take correspondence school courses and while he was in doubt regarding the value of the education thus received, he thought the fact that the men were sufficiently ambitious to undertake such courses should serve as one index of their ambition to better themselves.

Getting the Most from Crossties

By JOHN FOLEY

Forester, Pennsylvania, Philadelphia, Pa.

THE somewhat more than one billion crossties under the rails of the Class I common carriers of the United States not only constitute an integral part of the track structure, but represent a large financial investment. If only one cent per tie could be cut from the annual cost of those in track, the saving would be over ten million dollars a year.

You are aware of the proportion of maintenance of way expenditures that goes for crossties. On no item is more money spent, and on none is there more chance to save money. Those responsible for maintenance of way expenses cannot be expected to keep them at a minimum if they are not supplied with crossties suitable for the service expected of them. They cannot expect satisfactory service from the ties provided if their operations are not carefully conducted with a view to reducing the destructive factors in tie life to a minimum.

Toward the end of the last century, when railroad mileage was increasing steadily and the choice of wood for use under the rails was confined to the few species that were the most durable, there was reason to believe that the supply of ties would be practically exhausted before now. Undoubtedly we would by this time be making extensive use of substitutes for wood if artificial durability had not been imparted to a greater number of woods than those naturally durable and thus increased the potential supply of ties by making available for such use woods that were originally considered unfit for use in track.

Must Be of Ample Size

During the period when the procurement of naturally-durable ties became increasingly difficult, the vanishing forests and dwindling timber resources of the country provided the basis for arguments that railroads would have to use crossties of smaller dimensions and poorer quality. In recent years the situation has changed. Railroad mileage has not increased; it has decreased. Crosstie consumption has not increased; it has decreased. Forest economists are not sure that a timber famine is as imminent as it once seemed. So there is no ground for the assumption that a general shortage of supplies necessitates the acceptance by the railroads of inferior ties, smaller in size and lower in quality than are required for good track maintenance.

John Foley

There is ample assurance of an adequate supply of wood fit for crossties, in sizes suitable for the high speeds and heavy loads that characterize improved rail transportation, for as far into the future as we have any right to hazard any forecast.

During the past decade the Committee on Ties of the American Railway Engineering Association has observed stored stocks of ties in various sections of the country, and has seen so many millions meeting the requirements of A.A.R. specifications as to remove all doubt about the ability of any railroad to obtain standard ties. All that is necessary for the procurement of satisfactory ties for any service is adherence to well-known standards in their inspection.

Unfortunately, variations in the application of specifications have been so wide that the American Railway Engineering Association in 1926 deemed it necessary to urge all members "to make observations of their own ties. In the first place, they should insist that each tie be marked to show the size at which it was accepted. Then the membership will be able to see whether ties accepted and paid for as of a given size actually meet the standard requirements of that size. Interest in the character of ties delivered on the part of those responsible for their use would correct much of the fault in the procurement of ties. The oversizing of ties will cease whenever those receiving them question the marking of any which are too narrow or too thin for acceptance at the given size."

Again in 1927 this committee urged that "the user of ties insist on the delivery of standard ties, in standard sizes, stamped so that the responsibility for the acceptance of them can be placed." While there has been a marked general improvement in inspection practice during the past 10 years, there are still departures from good practice which warrant repetition of the above suggestions.

The producer of ties will make only what the railroads will take. Therefore, the output of substandard ties is to a large extent under railroad control. So long as there is lack of uniformity in railroad inspection, some manufacturers will

gamble that some railroad will accept what others will not. Some manufacturers figure that it pays to produce ties acceptable by any railroad; others that it is better business to carry poorer ties and cater to the railroads that are not particular about adhering to specifications.

Since getting the most from crossties is so largely a matter of getting good ties in the beginning, their inspection is very important. Knowledge, intelligence, experience and tact are required for results satisfactory to both consumer and producer. If you have occasion to transfer an employee to duty as an inspector of crossties, do not consider it as an opportunity to get rid of one you regard as of little use.

Procuring crossties of standard soundness and size does not in itself assure getting the most from them. Those that are not to be put in track as soon as received from the shipper, must be given attention to insure that their condition when inspected and accepted will be maintained. Wood is subject to deterioration from natural causes in its raw state, and ties suffer most from splitting and decay. While research promises to develop chemical means for regulating the movement of moisture out of wood and thus control checking to a considerable extent, it is not yet practicable to handle ties so that they will dry uniformly throughout. Uneven shrinkage of the wood causes spliting, which should be prevented from progressing to the point that renders a tie useless.

Effective devices for reducing the number and extent of splits are available, and their application at the time, in the position and in sufficient quantity to prevent serious damage will contribute toward getting the most from crossties. However, satisfactory results from the use of anti-splitting devices are obtainable only when they are supplied with care. Random placement may be harmful instead of helpful.

Sound crossties which are stored on unsanitary sites are soon infected with decay, and those who have to hold untreated ties will not get the most from them if poor drainage, rank vegetation, insufficient air circulation or long storage, alone or in combination, start the deterioration of the crossties before they are put in track.

Protection Against Wear

The protection from wear under the rail which tie plates are designed to give the ties is most effective only when the bearing areas are in one plane. Machine adzing before the tie is installed insures the best results. Not only hewed ties but sawed ties also, should be made level and smooth, since the latter are not always sawed with parallel tops and bottoms, and even when they are they seldom stay so under the warping that takes place as they season. If the adzing of treated ties by hand or machines in the field exposes white wood, the painting of the adzed area with creosote is a conin getting the maximum from the crossties.

Plates with bottom ribs designed to anchor the plates to the ties by seating themselves under traffic do so at the expense of the wood fibers they break and crush. Machining a groove for these ribs reduces the destruction of the wood and thus aids in getting the maximum from the crossties.

The driving of spikes has a tendency to split the wood, which tendency is greatly lessened if holes are bored for the spikes. Spikes are held tighter by the wood when driven into bored holes, because there is less mutilation of the fibers than when the cut spikes rive the wood. Where the number of rail sections used is not so great as to make boring impractical, pre-boring for cut spikes lessens destruction to an extent which will help in getting the most from crossties.

Effectiveness of Treatment

Preservative treatment is a major factor in getting the most from crossties, provided they are not allowed to decay before treatment, are sufficiently seasoned to be properly penetrated, and carefully processed with an efficacious preservative. By such treatment as had been given ties during the last 30 years, decay has been eliminated to an extent which made it possible to curtail annual replacements from 100,000,000 to 40,000,000. Statistically, the indicated trend is for an average annual replacement of 50,000,000 ties, a low rate of consumption that is possible only if ties are protected from decay until they are worn out.

The satisfactory seasoning of crossties to be given preservative treatment is possible only when storage yards are prepared for that purpose and cared for in a manner to eliminate decay. Leaving ties in varying quantities at numerous places along the right-of-way where they have been accepted results in the decay of many of them before they are treated. The preservative may stop the progress of decay, but it will not restore the unsound wood to a sound state.

Roadmasters supplied with crossties carefuly inspected, effectively "ironed" to stop serious splitting, properly machined for plates and spikes and thoroughly treated are in a position to get the most for their money if they will give the well-prepared crosstie the care justified by the investment in it.

Rough Handling

Ties are heavy and unwieldy, and in consequence cannot be handled gently. They can stand much rough handling, but it is recklessness to drop them upon rails or rocks from such heights that they will become broken. Moving treated ties with pointed tools is a careless procedure. The puncture of a pick may penetrate past the treatment to a point where the wood resisted the diffusion of the preservative to the desired depth. Forcing ties into position when spacing and alining them by blows with a spike maul results in mashed, softened wood fibers which provide a focal point for decay to start.

The advantages of bored spike holes in crossties are lost if the driving is carelessly done; the spike must follow the vertical hole if there are not to be less fibers holding it than if the hole had not been made. The removal of loose spikes as promply as practicable lessens the likelihood that the space around them will provide an entrance for decay. The filling of the holes with plugs driven to the bottom re-establishes effectiveness of the tie.

Careful Selection

The several standard sizes of crossties are designed to permit such selection as may suit the requirements in tracks of varying traffic densities. Using Size 1 where Size 5 is required would not be getting the most from crossties.

The several standard groups of woods provide kinds having strength values which permit selections to meet different traffic conditions and types of track. Where both Group a and Group b ties are available in a railroad's stocks, the use of Group a ties in the tracks of heavier traffic and in curves will get the most from crossties.

The pre-adzing of ties has greatly reduced the number inserted with their bottoms up. Pith shakes, which are common in broadleaved woods, generally develop into deep, extensive cracks when exposed to the weather, as they are when not turned underneath as placed in the ballast. These fissures may extend

past the treated area, which is thinnest where the heartwood (in which the pith is located) is exposed on the defined bottom of the tie. Getting the most from crossties requires more care in placing the defined top of a tie up in track than has been taken in many quarters.

In the limited time at my disposal it has been possible to consider only sketchily how to get the most from crossties. The possible procedures are known to you. Referring to them serves to remind us that there are ways and means which we should not overlook in our aim to reduce railroad expenses. There may be conditions over which we have no control that prevent the rigid application of what we may regard as the best practices to date; but perhaps we can adapt them to our local situations, and even improve them.

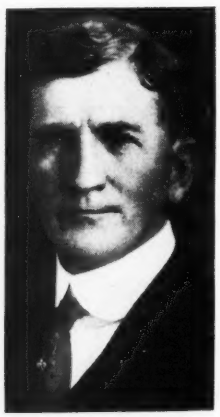
Your practical knowledge and your familiarity with the problems of track maintenance makes unnecessary a list of rules to be governed by and a lot of "don'ts" to remember, for you have proved by the unexpectedly-low replacements during the last five years that you are not in the beginners class at getting the most from crossties.

Inspection of Rail

Factors to Consider and Inspections to Make to Determine When Rail Should be Relaid or Measures Adopted to Extend Its Life

Report of Committee

THE conditions which make the renewal of railway rails necessary are not constant. Until a few years ago the rails in important main tracks were renewed when their ends had become worn or battered to such an extent that the cost of maintaining the track in good riding condition became greater than the expense of renewing the rails. By the development of the practice of building up rail ends by welding, the effective service life of rails in track was extended materially and with improvement of the welding process, particularly the grinding of the repaired rail ends to a true surface, the conditions which made the renewal of rail necessary have been changed greatly from those of a score of years ago.



C. W. Baldridge
Chairman

Costs

In a study made not long ago to determine the need for the renewal of rail, it was found that by building up 63 per cent of the rail ends and applying reformed joint bars to 63 per cent of all joints, the rail could be made to last several years longer. The relation of the cost of this work to the cost of laying new rail was found to be as follows:

Cost of relaying new 112-lb. rail (omitting resurfacing and lining), $14,057 per mile.

Cost of building up 63 per cent of the rail ends and applying reformed joint bars, $602 per mile.

The difference in cost per mile, therefore, was $13,455. The interest on this sum, at 5½ per cent amounts to $740 for one year. Therefore, the figures show that an added life of only one year would pay for the repairs made, and that all added life over one year is clear gain.

The development of methods for repairing rails in track has produced a marked saving in railway operation and maintenance costs. Not only does the added life of the rail represent a saving, but the repairing of chipped and battered rail ends each year results in a large saving in maintenance labor that would otherwise be spent in surfacing the low spots that continually result because of such joints.

Under present conditions rail should not be renewed so long as its condition throughout its length is satisfactory. There has been a marked increase in the life of rails now approaching the renewal stage and a similar increase may be expected in the life of rails in the future. With this increase in life assured, there is little likelihood of a pronounced increase in the volume of renewals over a short period at any time in the immediate future.

Despite the increased service life of rails that has been accomplished by repairing, the time comes when they must be replaced, and in making the determinations as to when the renewals are due, it is obvious that the officers in immediate charge of the track and its maintenance (the roadmasters or supervisors) should initiate the programs.

On some railways the preparation of a rail renewal program is a standing order of procedure and the roadmaster makes up his statement of rail needed for the coming year and forwards it to the officer to whom he reports. On other roads some higher officer sends out a call for such a statement, but in either case the actual origin of the list of requirements lies with the roadmaster. Owing to the fact that each roadmaster, or supervisor, passes over the district under his supervision frequently, it is not often necessary for him to make a special inspection trip to determine what rail on his district will need to be renewed within the year. Sometimes, however, his inability to get needed repairs made may cause him to list rail for renewal which in fact should be repaired and carried to some future time before it is replaced.

From the roadmaster the renewal program goes to the division engineer, the superintendent, or to whomsoever he reports. Usually the officer to whom the report is sent checks over the list submitted by each of his roadmasters and unless he is himself well enough acquainted with his division to pass upon the need for rail renewals, he makes an inspection trip over the locations involved and then forwards the renewal list to his superior officer with his recommendations.

Final Recommendation

Some railway managements require that the original lists prepared by each of the roadmasters shall remain with the papers until the pro-

gram is placed before the ranking operating officer. Thus every officer through whose hands this file is passed can judge the extent to which considerations of economy have had a bearing on the recommendations made. This plan naturally increases the incentive for the exercise of prudence and judgment in the making of recommendations. It is desirable to have the final recommendations made by some one who is equally responsible for renewals on all parts of the system and who is informed as to where new rail is most needed. Therefore, on most large railway systems the engineer maintenance of way or some special representative is delegated to make an inspection of all rail, the recommendations for the renewal of which have been approved by those who have seen the lists.

Preliminary to making his recommendations the roadmaster should consider the following factors:

1. Safety of trains as affected by the condition of the rail.
2. Riding quality of the track as affected by the condition of the rail.
3. Cost of track maintenance as affected by the condition of the rail.
4. Cost to renew the rail.
5. Renewal of ties, ballast, etc., which may be badly needed and the savings, if any, that can be effected in making such renewals along with rail renewals as against doing the work at once with the rail renewals postponed to some other time.

General Inspection

The factors which should be considered by the engineer maintenance of way or the special inspector who represents the management include:

A. Condition of the rail.
B. Availability of capital.
C. Requirements for relayer rail.
D. Prospective changes in the section of the rail to be used.

Factors Affecting Renewal

A. (1) Safety of trains as affected by the condition of the rail.
(2) Riding quality of the track as affected by the condition of the rail.
(3) Cost of track maintenance as affected by the condition of the rail.
(4) Cost of renewal with new rail.

Factors Affecting Repairs

1. Cost of repairing the present rail and fastenings.
2. Cost to maintain the track after repairs are made.
3. Greater cost, if any, of inserting new ties and resurfacing after repairs rather than after renewals.
4. Net cost to repair and carry the old rail versus the net cost of renewal.

B. Capital:

1. Are funds available for immediate renewal?
2. Can greater improvement of the track as a whole be made with the funds available by using them for repair work or for renewals?
3. Will the advantage of postponing renewal until funds are more readily available be commensurate with the deterioration resulting from such postponement?
4. Will the postponement of renewals by making repairs cause an excessive volume of renewals at one time in the future?

C. Relayer Rail Requirements:

1. How urgent are the requirements for renewal rail on tracks to be relaid with second hand rail?
2. Do such requirements justify anticipating the main line renewals?

D. Prospective Changes in Rail Sections to be Used in Main Tracks:

1. If a change to a heavier section of rail is in prospect, will such change justify delaying renewals?
2. Will such a change in rail section produce savings which justify anticipating renewals as soon as the heavier section is available?

Condition of the Track

1. Condition of the ties.
2. Condition of the ballast.
3. Surface of the track aside from the condition of the rail.
4. Drainage of the track.

General Inspection Studies

Factors which need to be studied to determine the condition of the track:

1. Amount of traffic handled by the rail.
2. Density of traffic.
3. Alinement of the track (number, degree and length of curves).
4. Grade (controlling).
5. Speed of trains.
6. Condition of ties.
7. Kind of ballast.
8. When last surfaced out of face.
9. Kind and condition of rail joints.

To Determine Condition of Rail

1. Contours of rail (not of much value).
2. Batter measurements at rail ends.

Safety of Operation Is an Important Factor

3. Per cent of rails which show wear spots.
4. Per cent of rails showing driver burns.
5. Per cent of rails having chipped ends.
6. Per cent of rails having sufficient batter to require repair by welding.
7. Per cent of rails damaged by broken wheels, kinked, bent, etc.
8. Number of failures throughout the service life of the rails, by years.
9. Kinds of failures.
10. Number of rails of known transverse fissure heats that are still in track.
11. Is bad riding condition due to the condition of the rail or inadequate track maintenance.
12. Number and condition of turnouts and crossings.
13. Percentage of rail ends which have ben repaired by welding.
14. Corrosion and brine eaten condition of rails and fastenings.
15. Line and surface of track.

Repairs Versus Renewals

For determining cost of repairs, check:

1. Number of joints in which rail ends need to be built up.

Rail on Curves Requires Special Consideration

2. Number of joint bars needing renewal, reforming or shimming.
3. Bolts needing renewal or improvement by springs or washers.
4. Per cent of ties that will require replacement if rail is renewed.
5. Per cent of ties that will require replacement if rail is repaired.
6. Effect of rail repairs on resurfacing requirements—can resurfacing be postponed?
7. Annual saving in cost per mile of maintaining and operating the road by renewing rail.
8. Annual saving in cost per mile of maintaining and operating the road by repairing the rails.

Method of Inspection

The inspections can best be made by riding over the track involved on a small motor car run at a sufficiently slow speed (10 to 15 miles per hour) to permit the inspector to see and record on tally counters the number of wear-spotted rails, driver-burned rails, and of defective rails, if any. Stops should be made at six or eight places on stretches of track not exceeding six or eight miles in length. Where longer stretches are listed for renewal, stops made from one to two miles apart are sufficient. At such stops contours should be taken of two opposite rails and measurements made of the depth of batter and wear at rail ends and of the amount of space left for expansion at 10 joints (5 on each side of track) or more if found desirable. Also, at three or four times during a day the temperature of the rail should be taken, the thermometer being placed first on the base of the

rail on the shady side, then on top of the rail in the sunshine. In addition, a check should be made at each location of the number of ties, out of one hundred which will need renewal when new rail is laid, if it is allotted as a result of the program, as well as an inspection and count of joint bars, tie plates, etc.

General Condition of the Track

While making measurements of the depth of batter at rail ends, notations should be made of rail ends repaired by welding, rail ends chipped, joint bars cracked, etc. The condition of the track as to line, surface, etc. should be observed by the inspector as he passes over the rail involved and notes made for reference when writing up the report.

Preparing the Report

A report should be prepared from the information thus collected, starting with a statement of the division, the mile-post location of the beginning and end of the rail under consideration, and proceeding through the history of the rail to be replaced, followed by the information developed by the inspection. Such contours as may have been taken can well be traced and prints of them included in the final pages of the report, for such information as they present, with the inspector's recommendations following the presentation of the other information.

Factors, other than the condition of the rail, which should be considered where financial conditions limit the rail renewals to an amount below what is actually needed, are:

1. The allotment of new rail among various locations (otherwise equal) in such a way that the released rail for main track repairs will be available for use at a minimum outlay for hauling and distributing.
2. The allotment of rail to localities of greatest risk to traffic from failures which might occur in the old rail if it were not replaced.
3. The allotment of rail to locations of greatest traffic density or of greatest wear.

In making his recommendations, the inspector should be on his guard against approving the renewal of rail where rough riding track is the result of poor maintenance instead of poor rail, but should recommend improving maintenance instead. He should also be careful to recommend the renewal of that rail which is in the worst condition and most in need of renewal.

Conclusions

Safety of train operation, while usually listed as the first factor to be considered in determining new rail requirements, is, in fact, dependent upon the condition of the rail, and almost every other factor reverts to the same basis. Therefore, the committee's work is an effort to outline the various features which show when the condition of the rail is such that renewal is required.

The running surface of rails at the ends can be repaired by welding and made as good as new. The wear under the head and on top of the base of the rail where they are in contact with the joint bars can be compensated for by reformed or specially made joint bars, and sometimes by shims, thus extending the service life of the rails almost indefinitely. Therefore, the physical conditions which make the renewal of rails necessary are wear spots in the running face of the rail, damaged spots such as driver burns, nicks made by broken wheels, or in some other manner, bends in the rail

Special Inspections Are Sometimes Necessary

both vertical and horizontal, including driver kinks and bends, curve wear, flow of metal or flattening of the heads of rails which chance to be softer than the average, head wear due to the abrasion that occurs on all rails in service, tie-plate wear into the base of the rails and corrosion of the base and web of the rails. When any one of these conditions or a combination of several or all of them make the rail unsuitable for further use in the track in which it is located, its renewal is necessary.

An undetermined factor in track maintenance which stands out as a challenge to roadmasters and supervisors is the determination of the cost of keeping in surface a rail joint where the rail ends are chipped or badly battered, as compared with the cost of building up the rail ends. The cost of repairing the rail ends by welding is quite well known, but no one seems to have counted the cost of tamping up the joint ties with badly battered rail ends, or the frequency with which it must be done.

Committee: C. W. Baldridge (chairman), assistant engineer, A.T. & S.F., Chicago; J. B. Martin (vice-chairman), general inspector of track, N.Y.C., Cleveland, Ohio; W. F. Monahan, general track inspector, S.P., San Francisco, Cal.; N. M. Gamble, supervisor, Wabash, Peru, Ind.; M. M. Killen, roadmaster, G.C. & S.F., Silsbee, Tex.; S. Payson, roadmaster, St. L.-S.F., Enid, Okla.; F. J. Liston, terminal roadmaster, C.P.R., Montreal, Que.; H. W. Stetson, general supervisor maintenance of way, Maine Cent., Portland, Me.; A. B. Chaney, division engineer, M.P., Poplar Bluff, Mo.; J. J. Clutz, supervisor, Pennsylvania, Trenton, N.J.; O. R. McIlhenny, roadmaster, T.C. & I., Ensley, Ala.; I. D. Talmadge, roadmaster, N.Y.O. & W., Middletown, N.Y.; H. R. Clarke, engineer maintenance of way, C.B. & Q., Chicago; J. G. Sheldrick, resident engineer, M. St. P. & S.S.M., Minneapolis, Minn.; F. H. Masters, assistant chief engineer, E.J. & E., Joliet, Ill.; G. L. Griggs, Jr., roadmaster, C.B. & Q., Centralia, Ill.; W. C. Pruett, general foreman, M-K-T., Muskogee, Okla.; W. L. Spyres, roadmaster, K.C.S., Heavener, Okla.; G. H. Strople, supervisor, B. & O., Callery, Pa.; W. J. Daehn, roadmaster, C. & N.W., Sparta, Wis.; L. E. Thornton, assistant division engineer, Alton, Bloomington, Ill., and P. F. Muller, roadmaster, C. & W.I., Chicago.

Discussion

F. B. LaFleur (S.P.) raised a question concerning the safety of rails nicked on the head by broken wheel flanges or on the base by anti-creepers struck by derailed wheels. As regards base nicks, there was general agreement that if the nick is of any consequence, the safe step is to remove the damaged rail immediately. William Shea (C.M. St. P. & P.) suggested that the best way to avoid this character of damage is to place the larger part of the rail anchors on the gage side of the rail where there is less likelihood of destructive impacts by derailed wheels.

As regards nicks on the heads of rails caused by broken wheel flanges, there was the general feeling that where the nicks are deep and abrupt, the rails should be removed promptly. On the other hand, it was felt by many that nicks more like dents, caused by breaks in wheel flanges after they had become rounded off, presented little hazard to safe train operation. However, it was brought out by B. E. Haley (A.C.L.) that it is the practice on his road to remove promptly from the track all rails nicked to any extent on the head or base by defective wheels. Mr. LaFleur said that the same general rule applied on the Southern Pacific.

President Chinn questioned the advisability of removing all head-nicked rails, regardless of the size or depth of the nicks, and reminded the convention that maintenance men as a rule do not consider it necessary to remove rails nicked by misdirected spike maul blows. He agreed that

rails with deep sharp nicks in the head should be removed from the track promptly.

Mr. Shea said that they were not particularly concerned about small nicks on the heads of rails on the Milwaukee, but that nicked bases and deeply nicked heads were considered dangerous. Rather than remove rails so damaged, it is the practice on his road to apply a pair of angle bars at the point of nick. This, he considered, eliminates all possibility of danger through the fracture of the rail, and is much more economical than changing out the rail. B. C. Dougherty (C.M. St. P. & P) agreed with Mr. Shea that the application of angle bars about a nick in the base of the rail, with bolts in only the two end holes, is safe and by far the most economical way of correcting the potentially dangerous condition. Both Mr. Shea and Mr. Dougherty agreed, however, that if there are a number of base nicks or deep head nicks in any one rail, the rail should be replaced.

Chairman Baldridge agreed that sharp, deep nicks in the rail head are much more serious than blunt indentations, regardless of their cause, but cautioned that one should not stop his examination of rails nicked by a broken wheel flange at the point where the sharp indentations run out, but should carry his inspection throughout the length of track nicked in any manner, to be sure that a subsequent break in the wheel flange, or enlargement of the initial break, does not cause a recurrence of the sharp, deep nicks. Answering a question concerning the advisability of leaving vertically kinked rails in track, Chairman Baldridge said that, in his opinion, kinks of any consequence caused by driver blows present a hazard, and rails containing them should be removed from the track.

The question of the danger involved in driver burns on rails, raised by W. P. Nichols (C. & O.), disclosed rather widely varying opinions, although it was conceded generally that deeply burned rails should be removed from the track. Chairman Baldridge and President Chinn contended that driver burns caused in extremely cold weather, or by engines in snow drifts, were much more serious and likely to cause rail breakage than burns made during milder seasons. Both felt that these burned rails should be removed from the track. Mr. Shea, while recognizing the greater hazard of burns caused in snow drifts, expressed the opinion that unless ordinary burns are 1/16 in. or more deep, they are not dangerous, and has found that they will gradually iron themselves out under traffic.

Both Chairman Baldridge and President Chinn considered it hazardous to repair driver burns by welding if outside of the limits of rail joints, Mr. Baldridge citing drop-hammer tests made on rails with repaired driver burns, which showed the rail greatly weakened at the repaired points, much weaker than similar burns unwelded. On the other hand, A. W. White (C. & O.) told of the successful repair of driver burns on his road by welding, with no indication of weakening of the rail. He said that at first the precaution was taken of applying angle bars about the repaired points but that this practice has now been abandoned, no failures having been observed in any of the many rails repaired.

Meeting Tomorrow's Requirements for Speed

By H. R. CLARKE

Engineer Maintenance of Way, Chicago, Burlington & Quincy, Chicago

IT WAS not until after I had accepted the invitation to address this convention on the subject suggested, that it occurred to me to wonder just what was in the minds of the executive committee when they said, "Tomorrow's Speed."

The committee report just presented has dealt with the speed at which we are operating today, speed has increased decidedly during the past two or three years over what was usual previously. Then what of speed in the future? We may each have our own ideas; some may think the present high speeds are the limit and others may believe that speed will be doubled in the future. So it becomes necessary to fix, if possible, what "Tomorrow's Speed" may be.

The response of the traveling public to the faster schedules indicates, I think, that those roads which have not yet put on such service will be compelled to do so, and that efforts will be made further to reduce the over-all running time, so that the service the railroads have to offer may be even more attractive.

In attempting to determine what the final maximum speed may be,

H. R. Clarke

there are two main factors to consider; (1) the equipment, that is, the motive power and cars; and (2) the permanent way, that is, track, bridges and signals. Since I know less about the first, or perhaps I should say, as I am supposed to know more about the second, I will begin by discussing equipment. I think this probably is the proper starting point, anyway, as the type of equipment in use will certainly have great weight in determining what the track structure must be.

The problem of safe and rapid deceleration is as important as acceleration. Speed is desirable only when it is attained safely. It may be more necessary to stop the train than to start it. Therefore, brake equipment must be studied, and with the best equipment so far designed a train running at 90 miles per hour will travel a distance of about 4,000 ft. before it can be brought to a stop. As speed is increased there are two alternatives; either the stopping distance must be lengthened or the appliances that stop the train made more effective. I shall not suggest that braking equipment may not be improved. I think it will, or even an entirely new principal of deceleration may be developed, but there are many factors which must be considered, such as, allowable brake-shoe pressures, wheel temperatures, adhesion of wheels to rails, possible damage to equipment, and safety and comfort of passengers. As a practical matter, some of these controlling

factors have, I think, already approached the desirable limit.

In the discussion of motive power, there are three types of locomotives to be considered; (1) electric, (2) steam, and (3) internal combustion—electric. At the present time, except in particular locations, either where traffic is very dense or where water power to develop cheap electric power is available, the electric locomotive is not coming into any general use, largely due to the cost of power transmission, so I think it may be eliminated from consideration. This leaves but two types, steam and the internal combustion—electric; the latter embraces two types, the gasoline engine and the Diesel engine. There are many gas-electric passenger motor cars in service and they have made splendid records, in both performance and economy, but the great development and improvement of the Diesel engine in the past few years has placed it in the lead, at least for long-distance, high-speed and fairly heavy service. This is due to its decided economy in operation and maintenance.

Steam or Diesel Power?

When steam and Diesel-electric locomotives are compared we find that both have advantages and both have their advocates. In favor of steam is mentioned its greater reliability, its more flexible range of power and a lower first cost per horsepower. In favor of the Diesel-electric is its more economical operation, lighter weight, ability to make long runs without stopping for supplies or service, faster acceleration, the absence of smoke and cinders, and the fact that it is much easier on the track structure. Both will undoubtedly be given a thorough trial; at present probably no one would care to predict the final outcome, although the Diesel-electric seems to be growing in favor, at least for passenger train service.

With either of these types of motive power there is a mechanical limit to possible speed. The direction of movement of the reciprocating parts of a steam locomotive can be reversed only a certain number of times in a minute, and this, combined with the diameter of the drivers, which also has a practical limit, determine the maximum possible speed. The speed limit on a Diesel-electric is governed by the traction motors. Here, the banding and gear ratio determine the speed, for if the motor speed is too high the centrifugal force will be so great as to expand the armature winding and break the banding wires.

Inventive genius may, and no doubt will, develop improvements that will raise these restrictive limits. It is possible that a new type of steam engine may be developed. One road has already announced plans to build a steam turbine engine, but the maximum speed I have seen mentioned in connection with this engine is 110 miles an hour.

The Inspection Party at Gary as They Waited for the Train to Return Them to Chicago

I am not a mechanical engineer and do not want to pose as a prophet, but I should set 125 miles an hour as the practical economic limit for sustained speed, from the mechanical standpoint. Even at present speeds of 90 to 100 miles an hour, overcoming vibration in the cars has been a problem, and as the speed is increased, say, to the suggested 125 miles an hour limit, further improvement in car design, especially in springs, trucks and axles, will tax the skill of the equipment manufacturers.

What of the Track

If we accept this suggested limit as imposed by equipment or mechanical limitations, it then becomes a question as to whether the maintenance of way department can build and maintain a track structure that will permit such speed and whether the expenditure necessary can be justified economically. Preparing the track structure to carry trains at higher speeds is no new problem to the man responsible for maintenance of way. It has been with us ever since transportation by rail began.

For a hundred years it has been the responsibility of the men who build and maintain the track structure to keep pace with developments in the speed, weight and tonnage handled. How has it been done?

Basically the Same

The track structure of today is not to be compared with the track of early days, but wherein is the change? We have all read and seen pictures of track as it was 75 to 100 years ago. The earliest type of track comprised wooden strips for the flanged wheels to run on, very soon reinforced or armored with straps of iron to reduce mechanical wear. Then iron rails were fastened to large stone blocks set in the earth, and this type of construction quickly gave way to the wooden crosstie with a T-shaped rail, and this is still the basic type of track structure today. True, it has been improved and strengthened by providing heavy steel rails weighing 112, 131 and 152-lb. to the yard, instead of the light iron rail, as well as larger ties treated to retard decay, tie plates, rail anchors and ballast of crushed stone, slag, gravel, chat or other suitable and available material instead of earth. In other words, it has been subjected to great improvement and a high degree of refinement, with but little change in basic design.

This has been the development of a hundred years. The constant demand for higher speed and the increase in axle load and tonnage continually introduced new problems or revived old ones for the trackman, and these problems were solved by improved design and a higher standard of maintenance, heavier rail, more ballast, better line and surface, steady and constant development and progress, but with little change in fundamentals.

What we, at present, term high speed trains in passenger service are being operated over many thousand miles of track. The use made of these trains by the traveling public shows that they are approved. The fastest of these trains are operated at an overall schedule speed of a little over 65 miles an hour, but to average this they must run at speeds of 90 to 100 miles an hour at times and for considerable distances. Probably no one would dare to predict what the final requirements in track structure may be, but we have had sufficient experience to justify an expression of opinion as to what is necessary in track construction and maintenance for these speeds. (The committee report has covered this well.)

For a number of years in the past, trains frequently have reached speeds of 90 miles an hour and over. These speeds have not been general, but have been attained in selected locations where track conditions were fa-

vorable. The new schedules call for sustained high speed with no chance to pick and choose locations, so it becomes merely a problem of making all track as suitable for high speed as some track has been for a number of years, and to make possible the maintaining of high speed for long distances.

This means the correction or elimination of conditions that restrict speed. To make possible long runs at high speed will require a higher standard of maintenance, a greater degree of refinement, more attention to detail, but no important change in track structure. This conclusion is based on the assumption that motive power and equipment will be of proper weight and design.

Slow Trains Also Involved

If the problem confronting the man responsible for track maintenance was simply that of keeping track in shape for light-weight, high-speed trains it would be easy. It would not be hard if only heavy high-speed trains were involved. It becomes complicated and difficult when it is necessary, as it is and will be for a long time, to operate slow heavy trains, trains at medium speed and very fast trains on the same track. It is then that the trackman must study and weigh all factors, and compromise on the methods and practices that will meet all the conditions involved satisfactorily and at least expense.

Straight or tangent track does not impose a serious problem; it must not be neglected or overlooked, but all that is required is good line and surface. Curves are the limiting factor in the speed allowed, and introduce elements requiring study and adjustment, and, of course, as curvature increases the difficulties multiply.

The problems to be solved in the maintenance of curves are—

(1) Line, including spiraling or the introduction of easement curves.

(2) Surface, including superelevation.

(3) Elevation runoff, that is, the transition from level track on tangent to superelevated track on curves.

The committee report has discussed these matters in detail, and I need not repeat the discussion here.

The Speed of Tomorrow

We have considered meeting today's requirements for speed. What is tomorrow's speed and what more is necessary on the part of the maintenance of way department to meet it? Today's speed means distances of 1,000 miles or more at an average speed of more than 65 miles an hour and at times to insure this average speed, a top speed of 100 miles an hour is necessary.

Assuming, as suggested, that tomorrow's speed is to be 125 miles an hour, what then? First, of course, the equipment, including decelerating appliances, must be designed for this speed. If an engine of the reciprocating type is used, the parts must be so lightened and counterbalancing must be so exact that the dynamic augment and impact are reduced to such limits as the track structure will stand. Whatever type of motive power is used, the balance must be such and the centering device so constructed and maintained that "nosing" will not be excessive. This is perhaps one of the most diffcult problems to solve, but the effect of excessive "nosing" is one of the most damaging factors the maintenance man has to contend with. It has been the practice for entirely too long to design and build an engine and decide upon the speed and then begin to build a track structure to carry the load and stand the punishment. This procedure must now be reversed. We must determine first, what the track structure will stand after reasonable expenditures are made, and then build equipment that can be operated at the desired speed without resulting in damage to the track.

Means Lighter Equipment

In expressing the opinion that a speed of 125 miles an hour is possible without basic or extensive change in track structure, I have assumed that the equipment used will be comparatively light in weight and of proper design. I do not think 125 miles an hour is possible with the heavy reciprocating-type locomotives in general use today, without making very large expenditures to strengthen the track structure. We would have to strengthen many bridges. I am not sure that the heaviest rail in use today, or even the heaviest that we might consider practical, would stand the punishment. The cost, in view of the thousands of miles of track involved would, I think, be prohibitive. Even if the track structure could be made strong enough, the maintenance costs would be excessive.

Starting late in May, steam trains with the usual type of passenger engines and cars have been in service between Lincoln, Neb., and Kansas City, Mo., and between St. Louis, Mo., and Burlington, Iowa, to replace Diesel-powered, articulated-trains that have been temporarily assigned to other runs. These two schedules are not the fastest on which we were operating the Zephyrs, but we quickly found that it was more difficult to make the schedule with the steam trains than it had been with the Zephyrs, and the effect on track has veen very evident. To maintain the same degree of refinement in line and surface and to secure equally satisfactory riding condition, it has been necessary to add to the track forces and materially increase maintenance costs.

I think it will be decidedly less expensive to build equipment for the speed and service desired than to attempt to build and maintain track to carry heavy equipment at equal speed, so I feel that the burden is on the designer and builder of equipment.

We have only discussed passenger service and equipment and it is this that we generally have in mind. We must, of course, also consider freight traffic. How much will it be speeded up and what must be done to make such increase possible? Here again I believe we must begin with the equipment, if speed much faster than the present is desired. It is very common today for freight trains to be operated at 60 miles an hour and possibly faster. To speed up the overall time of freight trains, I think the first effort should be to reduce terminal or yard delay. To what extent this is possible I do not know. It will vary on different roads, but it is possible to some degree on nearly all.

It is my opinion that we cannot expect a running speed much in excess of that now generally prevailing with present equipment, and certainly not unless tonnage is further sacrificed. Economical transportation is secured by handling tonnage, and the extent to which a reduction can be economically justified will require most careful analysis.

Improving Signaling

A most important factor in the safe handling of trains at high speed is proper signaling. Signals must be adjusted to the higher speed. This includes both automatic roadway signals and highway warning signals. The automatic roadway signals must be so spaced as to afford adequate braking distances. The highway warning signals must be timed so that warning will be given far enough in advance of the train to protect those using the highway, taking into account the speed at which the train is traveling.

A track circuit that will insure adequate warning in a train traveling at 125 miles per hour will start the warning signal too long in advance for a train moving at 25 miles per hour, and this will not only be re-

sented by the public but will lead to practices that will actually increase the hazard. Signal engineers have already made some progress towards solving these problems, but here again cost must be considered.

So, with suitable motive power and equipment, no great change in the basic track structure should be necessary. On the trackman's part it becomes a question of greater attention to detail. On tangent I think that 125 miles an hour is possible. It will require almost perfect line and surface, excellent tie condition, and great attention to rail joints and rail ends, so as almost to eliminate rail end batter. None of these is impossible if sufficient money is available. Rail of improved quality with pre-hardened ends will be of value in attaining the required track standard.

We are not interested primarily in possible bursts of high speed. Shorter overall time is the objective, so it becomes necessary to consider the factors that restrict speed, and of these the most important is curvature. A 30-min. curve will allow almost any speed that is permissible on tangent and the superelevation will not be excessive. A 1-deg. curve with 7-in. superelevation will ride fairly comfortably at 125 miles an hour if in first-class condition and properly spiraled, but what of the effect on a train running 60 miles an hour or slower? Above one degree curvature, permissible speed is rapidly restricted, so if speed for long distances much higher than we have today is to be attained, an extensive program of curve reduction or elimination will be necessary. The expense of this would be prohibitive.

Some further shortening of schedules and an increase in over-all speed is possible if the power plants used are of such capacity, compared with the load, as to permit very rapid acceleration in the higher speed brackets and to hold the maximum speed regardless of grade. Here, again, it becomes a question of cost.

There are on all roads physical conditions, occurring more or less frequently, that restrict speed. Owing to the fact that acceleration is slow in the higher speed brackets and as the attainment of the maximum speed often requires more distance than is available between the restrictions, a reduction in overall time can be attained only by eliminating these restrictive conditions. By a careful study of the line and the selection of those locations that are most restrictive, or that most seriously increase the over-all running time, and correcting those which can often be done at a comparatively small expense, a marked speeding up of the schedule may be possible at a cost that is not prohibitive.

These are the problems that confront the engineer and the trackman in meeting Tomorrow's Requirements for Speed.

Building a Maintenance Organization

BY W. F. THIEHOFF

General Manager (retired), Chicago, Burlington & Quincy, Chicago

THE responsibilities of maintenance officers and employees are to build and maintain tracks, bridges, buildings, highway crossings, fences and wayside facilities to meet the requirements of competitive transportation safely and efficiently, having in mind the ever-increasing weight of locomotives and equipment and the speed at which they operate.

Individually and collectively, we have grown up with this development as employees and officers, and are confronted with the problem of how to organize to get the best results. Let us keep ever in mind that safety is the foundation. To build an efficient organization, we must start with the new employee—the laborer. He should be encouraged to believe that employment gives him opportunity for advancement, depending on the capacity which he develops for increased responsibility through personal effort and experience, following the instructions and example of qualified employees and officers.

Men are usually employed by the foremen. There is, I believe, greater need for care and good judgment on the part of employing officers in selecting new employees than ever before. During the last few years, employees furloughed because of force reductions have been returned to service as older employees have been pensioned or died, and the average age of employees remaining has increased, so that foremen should be instructed and encouraged to make personal efforts to check the age, physical condition, education and disposition of applicants with the thought and belief that men so employed should be available in the future for promotion to assistant foremen, foremen, supervisors, roadmasters, maintenance engineers, in fact, to any official position in the organization. When a man is in the service he should be instructed as to his individual duties, taught loyalty, his reactions considered and he should be encouraged to believe that if he qualifies, he will be promoted.

W. F. Thiehoff

Roadmasters should talk with their foremen and feel it their responsibility to check with them from time to time the qualifications, experience and development of the employees under their jurisdiction, encouraging the foremen in their efforts to employ and develop young men of good character and with capacity. The road to promotion is open, and advancement depends largely on these fundamentals.

Assuming that we have selected young men carefully, what next? Organize them into gangs, where by co-ordinated effort they may serve safely, using improved equipment and methods to produce efficiently and economically and teach others to do so.

Some Recent Changes

Within the last few years there has been a decided change in organization and the methods of doing work. Until comparatively recently all work except the largest and heaviest jobs, was done by section gangs, these being increased in size as needed to handle the work under way. Now on nearly all roads the sections are not only much longer

but on many, if not on most roads, the section gang itself is small and is used principally to police the property and do comparatively small and light jobs, while most of the work of maintaining the property is being done with special or extra gangs of a size and organization adapted to the work under way and supplied with such work equipment as will add to the efficiency of the gang.

For instance, on the Burlington until a very few years ago it was the practice to lay rail with a gang of 40 to 50 men. Possibly five or six of these gangs were working on the system at one time with limited supervision and the only equipment they had was a rail-laying crane. Now the practice is to organize a gang of 125 to 150 men with an assistant roadmaster in charge and such foremen and assistant foremen as are needed to supervise the work properly, equipping the gang with a rail-laying crane, bolting machines for taking off the old nuts and putting on the new, power drills and adzing machines. Some roads add additional equipment such as spike pullers and spike drivers, but so far on the Burlington we have not found the use of these of advantage.

That the large gang organized and equipped as above is an improvement has been demonstrated by results. Such a gang lays, on an average, over a track mile of rail a day and the work is done better and more accurately than before. This year with such an organization we laid 105 miles of rail in 94 working days on the system, between St. Paul and Chicago, Chicago and Denver, Denver to St. Joseph and St. Louis, and between Galesburg and Quincy, making a number of movements as the work progressed, the time consumed in moving being included in the working days.

A few years ago the cost under the old method with the small and numerous gangs was a little over $700 per track mile. This included the work-train and labor expense of unloading the new material and picking up the old. In 1935 with the new organization the average cost was about $475 a mile, including the same items of expense and in 1936, while the figures are not yet compiled, we think the cost will be still lower. The rate of pay was higher a few years ago than at present, but even when allowance is made for the difference in rate, the decrease in cost is from $125 to $150 per mile.

Surfacing gangs are organized in a somewhat similar way, with power tamping machines, power jacks when these will be of benefit, Jordan spreaders to plow off the shoulder, and improved ballast cars in which to handle and distribute the ballast.

Other Large Gangs

Some roads have gone even further than the Burlington, organizing large welding gangs, angle-bar renewal gangs, etc., on a system basis. So far, the Burlington has not gone to large gangs for such work, but we do supplement the limited section force with floating gangs of 12 to 15 men when and as needed on such work, rather than increasing the force in the section gangs.

Some roads have divisional organization, some departmental and some a combination of the two. The Burlington has a divisional organization, with some modifications. The roadmaster is the backbone of track maintenance and the master carpenter of bridge and building maintenance on each division.

Without any thought of offering our experience as the ultimate, I will explain our organization in some detail.

Primarily, the division superintendent is responsible for maintenance of way and structures on his division. The roadmasters, master carpenter and signal supervisors report to him and are subject to his instructions. To co-ordinate the work on each general superintendent's district, there is a district engineer of maintenance who reports to the general superintendent. He confers with the system engineer of maintenance, the superintendents and the roadmasters in handling maintenance work for his particular district.

The general superintendents report to and receive authority for maintenance expenditures from the general manager.

As system maintenance of way officers, we have a signal engineer, a structural engineer and a bridge engineer, each specializing in his department with such assistants as needed and an engineer maintenance of way on the staff of the executive vice-president who co-ordinates the departments and the maintenance work on a system basis. Standards are discussed with these several units by the chief engineer and recommended for approval to the executive officers.

Preparation of Program

Programs of work to be done are prepared by the engineer of bridges, the structural engineer, the signal engineer and the engineer of maintenance, after receiving recommendations from the district and division officers. These programs are discussed with all concerned and referred to the executive vice-president for approval. When these have been received, a copy of the program is given to each district and division for its information and authorities for expenditure are made in the engineer's office for each item. As approval is given by the executive officers, a copy of the AFE is given to each district and division as its authority to proceed with the work as material, equipment and force are available.

Usually at a meeting of district and division officers, with the maintenance engineer and the general manager, the organization to handle the work is discussed and agreed to, keeping in mind the service requirements, location of work, seasonal weather conditions, etc., so that the work on the program for the system can be completed during a reasonable season's work period.

Estimates of force are made monthly by division superintendents, consolidated by general superintendents for districts, checked by the engineer of maintenance and the general manager, and recommendations made to the vice-president for approval. When approved, each district and division is given a copy and unless some emergency expenditures not planned for are necessary, the superintendent is expected to keep within the amount authorized for his division.

This organization has been in effect for a number of years, our feeling being that it is important to have all concerned in the expenditures responsible for the results. We believe this combination has developed a safe, consistent, co-operative and economical maintenance organization, still leaving authority with the officers actually on the ground and holding them responsible for the safe and efficient condition of the property.

Summing up, the building of a maintenance organization begins with the employing officer who should use care in selecting young men and educating them so that step by step they can qualify for advancement and in turn teach younger employees. Then the roadmaster and master carpenter should plan their work and assign qualified employees to the different kinds of equipment and tools, with such supervision for each unit as will employ it to capacity and consolidate the several units into a gang where co-ordinated effort will produce efficiently and economically.

Curve Lubricators—

Their Economy; Considerations Affecting Their Installation

Report of Committee

THE wear of rails, wheel flanges and locomotive tires resulting from the operation of trains over curved track has long been recognized by railway maintenance men as a source of waste of materials and labor. When it is considered that more than 60,000 miles of track in this country are on curves the magnitude of the problem can be understood.

This waste is reflected not only in more frequent renewals of rails and ties and the turning of wheel flanges, but in the loss of locomotive tractive power. The passing of traffic increases the "pencil point" area of contact between new wheels and new rail, thus increasing friction and curve resistance. This wear of the rail increases much more rapidly than the degree of curvature. In fact, authorities state that it increases nearly as the square of the degree of curvature, which means, of course, that wear on a four-degree curve is almost sixteen times as much as on a one-degree curve. But, it is also claimed that the tonnage necessary to produce the same wear of rails on different curves varies almost directly with the degree of curve. We can at least state safely that the rate of wear of the rail on any curve increases as the rail becomes worn.

As the losses from operation over curved track became known to some extent, means were sought to reduce them. This led to the earliest method of "rail lubrication"—the application of grease to the rails by hand.

Studies Undertaken

With the object of devising more effective and economical methods of reducing rail and flange wear, studies were undertaken by both maintenance of equipment and maintenance of way men. Experimentation produced mechanical and semi-automatic devices for oiling and greasing wheel flanges from attachments to locomotives, among which was the method of applying graphite in stick form directly to locomotive tire flanges. This method employed spring action or gravity to keep the graphite in contact with locomotive drivers.

Some of the oiling devices that were developed for operation from engines or tenders were operated

H. E. Kirby
Chairman

manually by a member of the train crew while the train was traversing curves.

A similar type, much improved, is automatic and uses centrifugal force to activate valves when curves are reached. This type has the advantage of low cost operation, but observation of the device on the two roads using it gives the impression that it is somewhat limited in scope and effect. In this type live steam, which is employed to heat the oil in the tank and supply lines, is introduced into the valve where it is mixed with oil, diffusing the latter into a sort of concentrated spray as it is applied to the rail.

While a good grade of mineral oil of asphaltic base is used by these machines, the oil is apparently emulsified to some extent by the condensed steam. As a result, although the asphaltic matter tends to stabilize the oil, its adherence and lubricating qualities are somewhat lessened. Moreover, excessive lateral motion in the tender truck of the locomotive (to which part of the mechanism is attached) has the effect of nullifying the action of the device so that no oil is discharged on curves when trains are running at the speed for which the track is superelevated. Results at low speeds seem better than when the trains are operated at high speeds. Also, since it is difficult to adapt the nozzle to the varying conditions that are encountered, oil is quite generally applied to about one-third of the area on top of the rail head. Nevertheless, there are at least two roads which use this process of lubrication with some success, and it is apparently satisfactory for their traffic. These roads report that adequate protection is afforded by this device and that train tonnage has never been reduced because of the presence of oil on the top of the rail.

Oil Locomotive Drivers Only

The small locomotive flange lubricators, now in wide use, apply oil to locomotive drivers only. For this reason and also because of the type of oil used, it is very difficult for this type to transmit sufficient lubricant to protect any quantity of rail or wheels. At most only the first few wheels directly back of the locomotive are benefited.

The general opinion grew that an automatic device attached to the rail would give more satisfactory results. Accordingly, about ten or twelve years ago development work was begun on such machines, most of which, for mechanical facility of operation, were designed to use oil. However, certain factors were unfavorable to the successful use of oil, including operation on descending grades where the use of retainers in braking produced such excessive heat in wheel treads that the oil, having little or no graphite content, was quickly dissipated or burned until its lubricating properties were destroyed; the inability of many oils to withstand the great pressure exerted against the high sides of curves; the generally low adhesive qualities of oil; a high reaction to weathering agents such as sunshine, rain, wind and frost, resulting in more rapid evaporation and deterioration; and considerable wastage because of the plunger-squirt method of application commonly used, which also permits oil to cover the top of the rail. To eliminate these objections these devices have been improved until at this time most rail lubricators are designed automatically to apply grease containing graphite or heavy asphaltic oil.

Thus, the development of lubricating machines brought about experimentation in lubricants which showed that the heavy, asphalt-base

oils give more lasting results than light oils, as the former have more body, and adhere longer to rail and flanges. This feature is important, as light oil tends to run down the flanges and be thrown off by centrifugal force. It was also found, however, that the heavy oils varied considerably in consistency with marked changes in temperature, and that the earlier products often had the effect of plugging the pump and discharge holes, thereby making it necessary to incur the expense of cleaning the machines. Also, when drums of the lubricant were left standing for some time, the denser part would settle to the bottoms of the containers, leaving the thinner oil at the top.

Now, however, as the greases being used today are usually "hot-mixed" and contain from 12 to 18 per cent fine graphite, mixed uniformly, these faults are reduced to a minimum. As this type of grease adheres closely to the point of application on the flange, it is possible to place it in the curved flange throat without fear of its spreading to a serious extent on top of the rail. Hence, with a lubricator applying grease in the proper manner, there is very little wastage from grease thrown off, which has an effect on the appearance of the track as well as on the economy of the practice.

Grease Containers

When buying and storing grease, there are advantages in having it packed in half-size metal drums (20 to 30 gal. holding 180 to 300 lb.). Such settling as may occur will have a less pronounced effect in this type of container. Moreover, metal containers are preferable to wooden barrels, which are frequently broken while being unloaded from supply or local freight trains. Thought should be given to the matter of caring for the supply drums properly after they have been placed along the right of way near the lubricators. If it is not considered practicable to provide small individual houses at each point, it is well to furnish a conical shaped or other type of metal cover to place on top of each drum, under which a bucket can be kept. This cover, extending down the sides of the container, will serve to keep the lubricant free of cinders, water, and other foreign matter, which, if mixed with the lubricant, may result in the clogging of the greasing machine.

Before making installations of mechanical lubricators, full consideration should be given the several factors involved. The number of lubricators required will be governed by the amount of curvature, the life of the rail in its first location, the amount of traffic, the extent to which the grades are ascending or descending, etc.

The proper location of lubricators with reference to individual curves, and also in relation to the district as a whole, is of the utmost importance in securing best results. On individual curves the proper location of the lubricators differs with the types of machines. A plunger type oil-lubricator, for instance, should be placed from one to four rail lengths on the spiral of the curve, since, if placed back on the tangent, the jet does not always strike the desired point. In the case of a lubricator handling heavy grease, however, the location usually selected is on tangent track a short distance back from the end of the elevated easement curve. This location allows the application of grease to the area between the wheel tread and the bottom of the flange. We may say that, in general, a lubricator should be located near the point of curve, where the track is in level surface and one rail does not receive more wheel thrust than the other, as may be determined by inspecting both rails for equal wear.

On a double track line, where the bulk of traffic is in one direction, the lubricator should be placed on tangent track in advance of the curve, and other machines added as necessary to grease the greatest distance effectively with the fewest lubricators. In the case of a track carrying approximately equal traffic in both directions a lubricator should be placed in the curved territory a distance from the beginning equal to the maximum length of track that the machine will effectively lubricate. These distances can best be determined by trial of the lubricator under conditions prevailing on the particular track, which experiments may also influence the amount of the investment necessary to lubricate the territory. For instance, on a light-traffic district containing isolated curves, it may be found that the use of a small oil-type lubricator gives sufficient protection. However, if the curves are in a series of considerable total length, a reasonable amount of traffic would probably require, for economical lubrication, the use of a machine handling the heavier greases. The effective distance protected by a lubricator varies with the temperature, the kind of grease used, traffic conditions and the average amount of wear on the rail and flanges when lubrication is begun.

Some of the potential sources of savings from rail and flange lubrication are:

1. Maintenance of way
   - (a) Increased life of the high rail on curves
   - (b) Increased life of crossties
   - (c) Decrease of abrasion of the low rail
   - (d) Reduced wear of switch points and frogs
   - (e) Decreased derailment hazard
   - (f) Elimination of screeching noise on curves
2. Transportation
   - (a) Reduction in curve resistance
   - (b) Increased train speeds with safety
   - (c) Decreased derailment hazard
3. Maintenance of Equipment
   - (a) Reduction of wear on car wheel flanges
   - (b) Reduction of wear on tires of locomotive drivers

Maintenance of Way

There is much physical evidence of the extent to which the life of high rails on curves is increased by lubrication. Many railroads have taken cross-sections of the rails on particular curves to determine the relative wear before and after lubricating the rail. Contours of rails, taken on three railroads, are reproduced here (Figures 1, 2 and 3) as examples of the effect of lubrication under conditions obtaining on each of the railways, which are the Southern Pacific, the Norfolk & Western and the Chesapeake & Ohio.

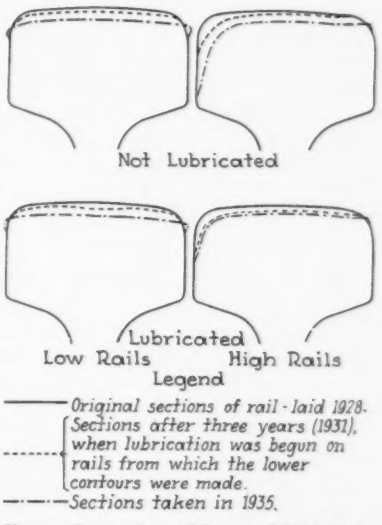
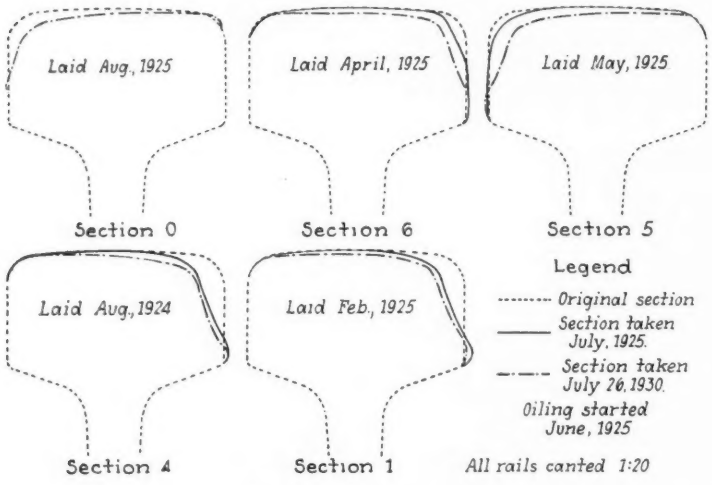


Fig. 1—Comparison of Low and High Rails of Lubricated and Unlubricated Curves

In Fig. 1, by comparing the two rail sections on the left it will be seen that the rail on the low side of the curve was affected but little by lubricating the high side. The difference in the sectional areas of the low rails in 1935 was 0.02 sq. in. or

0.4 per cent of the entire rail head. In the case of the high rails, however, there is a marked difference. Prior to the time lubrication was begun on one curve in 1931, the high rail on both curves had been worn approximately to the same extent, but after four years the unlubricated had an average worn area of 1.19 sq. in. It was then removed from track and replaced by new rail of the same weight and section, which, after remaining in track precisely the same length of time during which time it was greased, had worn only 0.26 sq. in. The ungreased rail



	Section 0	Section 6	Section 5	Section 4	Section 1
Grade (D = Descending)	0.9%D	0.48%D	0.78%D	1.07%D	Level
Curvature (All high rails)	11°-0"	9°-34"	8°-17"	9°-16"	6°-15"
Superelevation	4½"	4½"	4½"	4½"	5"
Distance oiling point to section in miles	1.62	4.04	6.41	0.65	11.34
Before Oiling					
Million Gross Ton-Miles Traffic		167.06	83.53	798.21	334.13
Square Inches of Rail Wear		0.083	0.045	0.270	0.250
Square Inches Rail Wear per Million Gross Ton-Miles		.000497	.000539	.000338	.000747
Rail in Service		2 Mo.	1 Mo.	10 Mo.	4 Mo.
After Oiling					
Million Gross Ton-Miles Traffic	5271.34	5438.40	5438.40	5438.40	5438.40
Square Inches of Rail Wear	0.284	0.290	0.362	0.156	0.210
Square Inches Rail Wear per Million Gross Ton-Miles	.0000505	.0000539	.0000666	.0000360	.0000386
Rail in Service since oiling began	59 Mo.	61 Mo.	61 Mo.	61 Mo.	61 Mo.
Ratio of Wear—Oiled Rails to Unoiled Rails		1:9.3	1:8.1	1:9.4	1:19.4

Fig. 2—Comparison of Rail Wear Before and After Lubrication

rail showed an abraded area four times that of the greased rail. At the end of this period the worn areas were 0.46 sq. in. and 0.11 sq. in., respectively.

Figure 2, which is made self-explanatory by the accompanying table, is interesting because of the differences in the amount of wear shown, the rail wear being from 8 to 19 times greater when not lubricated than when lubricated.

The two contours reproduced in Fig. 3 were made at two points selected as representative of wear on the high side of a 4-deg. curve over which an average of 24,142,188 gross tons of traffic have moved annually during the last ten years. New rail, after being in service ungreased for 3 years and 3 months, carried 62,567,715 gross tons during the 3¼-year period, while the greased rail handled heavier equipment and carried 90,942,464 gross tons during the first 3¼ years of its life.

In view of the information which has been received by the committee on the increased life of the high rails on curves that has been obtained by lubrication, we can state that, as a conservative estimate, rail lubrication increases the life of such rail 100 per cent or more, depending on traffic conditions, loads on engine drivers, grades, the weight and section of rail, and other factors. In fact, the figures given indicate that the life of lubricated rail is from 2.5 to 19.4 times greater than when it is not lubricated.

Another consideration is the effect of rail lubrication on the life of crossties on curves. As rails wear by flange cutting it is necessary to renew them or to throw them in to gage, thus making unavoidable some damage to the ties. Hence, a further saving, arising from the increased life of ties, may be expected as a result of lubricating the rail, but no definite figures are available at this time.

Effect on Low Rails

There is also evidence to indicate that a decreased abrasion of rail on the low side of curves results from lubricating the high rail. In the contours reproduced this difference amounted to 0.4 per cent. This is probably due to the influence of a uniformly lubricated outer rail on the longitudinal and lateral slipping which occurs in at least three wheels of a four-wheel truck as cars pass around a curve. Wear of the inner rail is of little economic importance, however, as the life of rail on the low side of curves is generally limited by the batter and mashing produced by the bulk traffic at lower

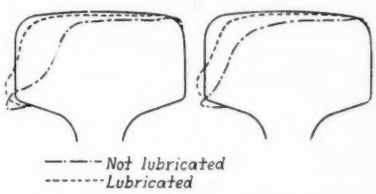


Fig. 3—Comparison of Greased and Ungreased High Rails

speeds. Nevertheless, recent developments in the practice of heat-treating rail may in the future alter the situation to the extent that wear may again become a factor of importance in this regard.

Yards and Terminals

Experience has proved the value of lubrication as applied to yards and terminals, reports indicating that when switch points are properly lubricated their life is increased approximately 100 per cent. The number of rail lubricating machines required is governed by the volume of traffic, car movements, the number of turnouts, lengths of leads and other conditions. In this service a lubricator can be so placed that it will take care of an entire ladder track, protecting curved leads as well as switch points. For these purposes lubricators are usually located on pull-in or hump tracks. And, as elsewhere, the benefits of lubrication are cumulative, and grease applied to wheels of trains

entering a terminal is frequently effective also on outbound routes.

It is the general consensus of opinion that lubrication of the outer rail on curves has the effect of reducing the probability of derailment from worn flanges and rail. While the facts provide some basis for this opinion, it is impossible to secure any records or definite figures in support of them. We do know, however, that this factor has been one of those considered in purchasing rail lubricators. Likewise, the elimination of the screeching sound produced on sharp curves, particularly in residential sections, has been an important consideration on some railroads.

Transportation

The potential saving resulting from a reduction in curve resistance produced by lubricating the outer rail on curves may later prove to be the most important single benefit derived from the practice. It is believed to be of sufficient importance to justify intensive study and experiment by any interested organization having available the funds necessary to conduct comprehensive tests. It is reasonable to believe that unit curve resistance, which is usually considered as varying, other things being equal, with the sharpness of curvature, will be reduced somewhat by rail lubrication, but up to this time there have apparently been no tests made to determine this effect. Statements have been received from a few railroads, however, to the effect that the tonnage rating of trains has been increased following the installation of rail lubricators. The increases, however, are given only in one case—that of a 10-deg. curve located at the top of a 1½-per cent ruling grade. The general manager of the road stated that, as a direct result of greasing the curve, tonnage has been increased 15 to 20 per cent. Increases in train tonnage are usually made following changes in grade and line or the introduction of improved motive power, making it difficult to separate the influences of these factors from the effects of rail lubrication.

As previously pointed out, the general consensus is that the practice of rail and flange lubrication has a marked effect in reducing derailment hazards, and has thus promoted safety while saving the operating expense that would otherwise be necessary. This item is somewhat intangible, however, and is not subject to definite evaluation. There also seems to be some basis in fact for the statement that rail and flange lubrication has permitted train speeds to be increased with more safety.

Maintenance of Equipment

Definite savings are effected by increasing the life of car-wheel flanges and locomotive tires, but they cannot readily be determined from available records. This is especially true of car wheels, the life of which, if known, would be of limited value to this study because the movement of cars is not confined to a single railroad. There are three cases in point, however, with respect to locomotive drivers. The Louisville & Nashville kept records of the tire maintenance of 30 locomotives operated on its Eastern Kentucky division for a six-months period after lubricators were installed on this division. It was found that, after deducting costs and annual charges of lubrication, a net annual saving of $5,852 is being effected. Thus the annual net saving in tire maintenance that is being effected by lubricating the rails is approximately $390 per locomotive. The Southern found that on one division rail lubrication extended the average life of the front tires on freight engines two months (from 2½ months, ungreased, to 4½ months, greased), an increase of 80 per cent. For passenger engines the increase was 1½ months, or 75 per cent. On the Big Sandy subdivision of the Chesapeake & Ohio it is reported that prior to lubrication of the curves it was necessary to change the tires of locomotive drivers every two months, but that since lubrication of the curves was begun the tires run approximately twelve months before being changed.

Costs

The cost per year to apply grease properly twice daily on one mile of rail by hand may be estimated as follows:

1,080 man-hr. labor	@ $0.40	$432.00
240 gal. grease	@ $0.36	86.40
Total		$518.40

Attention is directed to the fact that, according to tests, greasing by hand requires approximately twice the quantity of grease that is discharged by a mechanical lubricator where the amount of traffic is the same. In no case are results comparable. It seems practically impossible to apply grease by hand satisfactorily. If the quantity is reduced, the rail and wheels are not protected, while if a sufficient amount is applied it often results in the slipping of engine drivers and in other disturbances to operation unless painstaking care is employed in applying the grease. This is, of course, due to the fact that the wheels of locomotives collect most of the grease, forcing it under the tread. In certain cases the hand greasing of curves has been found to interfere with the proper operation of signal circuits.

Data pertaining to the operation and results of oiling rail by the several devices designed to distribute oil are unfortunately not available in sufficient detail to be given here. There is no doubt, however, that benefits to some degree are derived from the application of any lubricant, regardless of its density and form.

Lubricators Are Increasing the Life of Rails on Curves

There is evidence of the economy of using these mechanical oilers, particularly on light-traffic districts, but on any territory where the curves are not too concentrated; where they are not in excess of about 2,500 ft. in length; and where the grades (ascending or descending) are not too severe. A principal advantage of this type of oiler is its low first cost, which ranges from about $60 to $100 per unit installed. Thus, under certain conditions, where a larger investment in lubricators could not be justified, this type of oiler should give adequate protection.

As there seems to be general agreement that a lubricant in the form of a thick paste or heavy grease is most effective, it follows that the more successful lubricating machines must be of such design as to handle this type of lubricant. There are four such machines on the market today, one of which is in especially wide general use. The essential features of these lubricators, varying in detail and method, consist of a grease container, a force-feed pumping mechanism actuated

by motion produced by the force of passing wheels, and a distribution system by which grease is finally discharged through a series of orifices along the gage of the rail.

It is believed that by making use of the outer edge of the wheel tread to produce motion in the pump mechanism of the lubricator, a more uniform discharge of grease is obtained than when this mechanism is actuated by flexure of the rail, as results under the latter method vary in

Where Curve Wear Is Heaviest

accordance with the weight of passing wheel loads producing the wave motion. Thus an even, continuous supply of lubricant is applied to the flange of each wheel, which, with machines properly adjusted, results in the uniform lubrication of rail and wheel flanges under any amount of traffic.

The costs of lubricating by this method vary somewhat, principally in accordance with traffic, but now appear to be lower than estimated at first. Latest reports indicate that the average cost may be near the figure given by the Southern, which is approximately $59 per year per mile of lubricated track. The annual cost on the Chesapeake & Ohio of operating 247 lubricators was $17,536.19, or $71 per lubricator per year. This figure includes the cost of the grease, of filling and cleaning the machines, and of the labor and materials applied in maintenance. Including annual investment and sinking fund charges, the figure becomes $29,703.36, or $120 per lubricator per year. The operating expense was distributed as follows:

Item	Total Cost	Cost per Lubricator
Labor to fill, clean, adjust, etc.	$ 5,698.80	$23.07
Grease	6,348.36	25.70
Repairs—labor	2,635.71	10.67
Repairs—material	2,853.32	11.55
Total	$17,536.19	$70.99

In common with all mechanical devices, a rail lubricator requires a certain amount of attention. The expense to clean, fill and adjust is very little, but it is important that this attention be given regularly. It will be reflected in the results obtained.

To avoid unnecessary interruptions to service, it is well to anticipate from experience the repair parts most often needed, and keep them in stock at division headquarters or at a readily accessible central point. A trackwalker, or at least one man on each section on which lubricators are in track, should be sufficiently familiar with the mechanical features of the machines to enable him to make adjustments and minor repairs. All other repair work on the lubricators should be done by the division road mechanic, who should also make frequent inspections of all lubricators. If the number of lubricators on a district is great enough to justify the cost, economy may result from the assignment of a trained man to maintain them. This practice is followed on at least one railroad, the Erie. On the Chesapeake & Ohio, however, the ratio of the average time required to fill, clean and attend lubricators (usually by a section man) to the time spent in making repairs (by road mechanics) is 14,245 hr. to 3,423 hr. or more than four to one. The average figures for all roads cannot be determined, but if those just quoted are representative, the matter is worth considering, especially if the filling and cleaning are done by a trackwalker, bluff watchman or any other employee in conjunction with other duties.

When considering mechanical lubrication, it should be kept in mind that an automatic lubricator is simply a vehicle for carrying the lubricant to the wheel flanges and that it is important to use a grease of high quality.

The accompanying tabulation should be of help in determining the added rail life that would be required to offset the cost of lubrication. It shows the necessary extension to the life of rail ungreased, where the latter ranges from one to ten years. The lubrication cost figures used in this example are very conservative; the scrap and relay rail quantities and values were those in effect on one railroad at the time the table was prepared.

The figures in the table are based on the following figures and computations:

Cost per track mile of new 131-lb. R.E. rail in place	$9,483.82
Salvage value of old rail per track mile 0.571 x $20. (relay) 0.429 x $10. (scrap) = $15.71 per ton $15.71 x 206.17 tons	3,238.93
Net cost per track mile of new rail in place	$6,244.89
Cost per year to grease one track mile, including 6 per cent interest on investment, annuity to replace based on life of 10 yr., and all repairs and operating expenses	$ 241.99

$$\frac{\text{Greasing cost per mile per year}}{\text{Net cost per mile new rail in place}} = \frac{241.99}{6244.89} = 0.03875 \text{ (a)}$$

Increased Life of Rail Necessary to Justify Cost of Lubrication

(1) Life of Rail Ungreased Years	(2) Annual Charge per Dollar, for Life in Col. (1)	(3) Annual Charge Less Cost of Rail Greasing Col. (2) minus (a)	(4) Life of Rail, Greased, Corresponding to Annual Charge Col. (3)	(5) Increase of Rail Life Necessary to Justify Cost of Rail Greasing Col. (4)–(1) Years	Days
1	1.06000	1.02125	1.039	0	14
2	0.54544	0.50669	2.163	0	59
3	0.37414	0.33539	3.384	0	140
4	0.28857	0.24982	4.714	0	261
5	0.23741	0.19866	6.171	1	62
6	0.20337	0.16462	7.779	1	284
7	0.17914	0.14039	9.569	2	208
8	0.16101	0.12226	11.581	3	212
9	0.14702	0.10827	13.863	5	315
10	0.13587	0.09712	16.506	6	185

Committee—H. E. Kirby (chairman), assistant engineer, C. & O., Richmond, Va.; O. V. Parsons (vice-chairman), assistant engineer, N. & W., Roanoke, Va.; R. H. Carter, acting division engineer, I. C., Chicago; L. T. Day, roadmaster, C. & N. W., Melrose Park, Ill.; L. C. Martoia, supervisor of track, Penna., Niles, Ohio; Joseph M. Miller, supervisor of track, West, Md., Westminster, Md.; G. C. Palmer, roadmaster, C. B. & Q., Kansas City, Mo.; A. L. Pollock, roadmaster, A. T. & S. F., Oceanside, Cal.; Roy W. Putnam, roadmaster, S. P., Oakridge, Ore.; Jack Stewart, roadmaster, S. P., Phoenix, Ariz.; O. Surprenant, roadmaster, D. & H., Schenectady, N. Y.

Discussion

President Chinn emphasized that, in addition to effecting an increase in the life of rails and wheel flanges, a secondary saving in connection with lubrication results because it is necessary to replace materials less frequently, thereby effecting a saving in labor. While stating that lubricators are used to only a limited extent on

his road, C. W. Baldridge (A.T. & S.F.) explained that, wherever he has been able to follow their use the reduction in rail and flange wear has been considerable.

R. W. Grigg (Penna.) stated that lubricators are applied freely on his road, particularly on freight lines on the eastern slope of the Alleghanies, and that, in addition to the increased rail and flange life that has been obtained, it has been possible to increase freight train tonnages to a substantial extent.

A. H. Peterson (C.M. St. P. & P.) described the practice of his road in connection with the use of rail and flange lubricators. These devices, he said, are used extensively at outlying points and are now installed to some extent in yards, about 12 of them being at present in service on sharp curves and on switching leads in this company's Chicago terminal. It has been his experience that switchmen take a keen interest in the operation of the lubricators and that, when one of them breaks down so that it is not working properly, they make an attempt to repair it themselves so that the cars will roll more easily. Mr. Peterson described one switching lead on which the switch points, frogs and the track in general were in such poor shape that the lead was referred to as the "clickety-bang" lead. After lubricators were applied on this lead and the track was put in shape by a general surfacing, improvement was so marked that this appellation is no longer applied. Mr. Peterson strongly endorsed that part of the report which emphasized the need for keeping repair parts for lubricators on hand.

W. O. Frame (C.B. & Q.) stated that lubricators have been used on his road for about 10 years and that his experience with them substantiates the statements made in the report. In the beginning, he said, lubricators were not applied in yards because of the fear that they would cause the wheels to slip. However, in one location at Kansas City, Mo., where lubricators were installed in a "gooseneck," no difficulty in this respect had been experienced. In this location, he said, in addition to affecting a substantial increase in the life of the rails the lubricators have eliminated the necessity of regaging the tracks frequently. He estimated that, whereas the life of the high rail at this location before lubricators were applied was about 15 months, it is now about 3 years.

H. H. Hahn (N.Y.O. & W.) said that he has 19 lubricators on his subdivision and that they have given very satisfactory results. In most cases, he said, the grease is distributed for distances of about 10 miles from the lubricator. From observation of lubricators installed at various points relative to curves, Mr. Hahn has drawn the conclusion that best results are obtained when the lubricators are installed on the curve a short distance from the end. He estimated that the lubrication of rail increases its life about 60 per cent.

Walter Constance (C. & O.) traced the history of rail and flange lubrication on his road from the time that various "home-made" devices were in use up to the present. In the beginning, he said, there was some objection to lubrication because of the fear that it would cause the wheels of equipment to slip. However, through improvements in the design of lubricators, this objection has now been removed, he said.

Taking Accidents Out of Track Work

By E. A. MEYER

Chairman, Association of American Railroads, and
Manager Safety and Fuel Departments,
Chicago, Milwaukee, St. Paul & Pacific

THE traveling public is becoming more and more "train conscious." More people are traveling by train. However, while most people are interested in streamlined trains, air-conditioned cars and high-speed trains, they fail to give credit to those who make it possible to travel in these luxurious trains in such ease, comfort and safety. You men, by careful maintenance of the tracks and roadbeds, have made train travel almost safety perfect. However, while you have reduced train accidents due to track conditions almost to a minimum and have looked well to the safety of the traveling public, some of you, while accomplishing these important objectives, have overlooked the equally important matter of safety for yourselves and fellow workers.

A number of years ago, my son worked on the section during several summer vacations as this type of work was helpful in preparing him for his athletic pursuits at college. The second summer when he started this work, after learning that he was to have a new foreman, he remarked to me, "Dad, I hope this man realizes that I am an experienced section hand and will give me some real work to do." Many people seem to think that any one can work on the section and that no instruction, supervision or training is necessary. Even some of the foremen seem to have this idea. How much more valuable, more competent and more capable of performing safe work is the track man who is well instructed in safety essentials and soundly supervised?

No beginner in track work knows how to do the work properly—he must be shown. There is a right way to do every job, even to the starting of a track spike in a tie. The railroad with which I am connected emphasizes the importance of this by means of a sketch in the Safety Rule Book showing how the spike and the maul should be held at the moment of starting the spike. Our foremen are required to train their men properly so they will not form unsafe habits. Webster defines habit as "An action acquired by frequent repetition." There is a wonderful opportunity for the foreman and the supervisor to see that their men form good habits instead of bad ones. The bad ones are difficult to break and frequently cause accidents. It is much easier to get a fish-hook into your hand than to get it out.

It is a great satisfaction to work where there are safety rules and it is a greater satisfaction to work where these rules are enforced. But the greatest satisfaction of all is experienced when the rules are being observed and men are not receiving injuries. It is well for all of us to take an inventory of ourselves occasionally. Each foreman and supervisor should ask himself these questions:

Do I instruct new men properly?

Do I give them credit for knowing more than they do?

Do I carefully supervise the way they do their work?

Have I taught them the proper way to handle tools?

Have I demonstrated to them the proper way to handle motor cars to prevent injury to themselves or the public?

Do my men know how to work safely around stationary or moving cars or trains?

I could enumerate many "do's"

and "don'ts" but you all know how the work should be done. You know the right way. You know the safe way. The crux of the campaign to take accidents out of track work is proper instruction and supervision, with the necessary follow-up to see that the instructions are obeyed. These functions must be carried out by the foreman in direct charge of the men. They cannot be delegated to someone else. The responsibility is his alone and he must meet it.

Before high speed trains were placed in operation, it was necessary to increase the superelevation on curves and to lengthen the spirals. This was a great engineering problem and after the plans were perfected, definite instructions were issued to the foremen. We will agree that such a procedure was necessary to the safe operation of highspeed trains and it follows that definite plans and instructions must be adhered to if injuries in the maintenance of way department are to be prevented. The thought I want to bring you is that for the successful completion of any piece of work, it is just as important to have definite plans for working safely as it is to have definite plans for working efficiently.

None of us wants to be injured. None of us wants to hurt anyone else. Therefore, it is the responsibility of the supervisor to see that the casualties in the maintenance of way department are reduced so that only those that can properly be classed as "acts of providence" are allowed to take place. You have heard of the man who could not see the forest for the trees; similarly in making the track safe for the traveling public, let's not become blind as to our own safety and to the safety of our fellow workers. When we broaden our vision so that we will look to our own safety as well as to that of the traveling public, then and not until then will we have taken accidents out of track work.

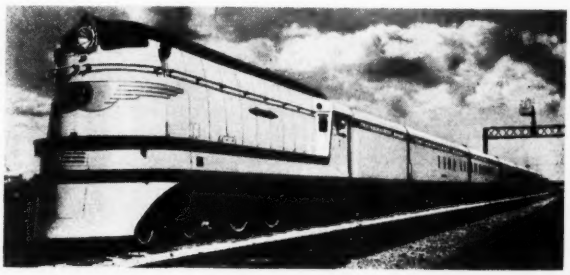
Preparing and Maintaining Track for High Speed Operation

Report of Committee

THE Preparing and Maintaining of Track for High Speed Operation, can be divided for convenience into three headings: (1) General considerations, (2) preparing track for high speed operation, and (3) the maintenance of track under high speed operation. The last year or more has been a momentous period in the establishment of higher speeds and safe operation on our railroads. Only those working for railroads, however, realize that this fast railroad service has imposed heavy responsibilities on the maintenance departments.

The most striking aspect of the present situation is that higher speeds have been attained on practically every railroad in the country. Any business, given sufficient funds, can provide a high class product. In the case of the railroads, the product is transportation, and the fact that they have been able to increase the quality of this product in the face of falling revenues, is an accomplishment in which they can justly take pride. Physical conditions of the roadway and equipment govern the speed at which trains can be operated with safety, and the provision of safe track for high speed in the most economical manner, has, no doubt, made many a railroad officer scratch his head. The roadmaster has certainly had to do about as much of this as anyone to get proper results with limited expenditures for labor and material.

High speeds today are not restricted to multiple-track lines; trains are operating just as fast on single track as they are on two, four and six-track territories. They are operated just as fast with the manual block as with automatic block signals. High average speeds are maintained just as efficiently in territories where the curvature and grades are severe as on lines where these features do not complicate the problem. They are operated through congested localities as fast as in open country. The inauguration of high-speed streamlined trains of entirely new designs led to the discovery that what we now call old-type equipment could compete with the new train if it was "opened up a little wider."



The Hiawatha of the Chicago, Milwaukee, St. Paul & Pacific

A Gradual Process

In considering the preparation of track for high speed, it is essential to point out that most lines did not provide the higher speeds (we are speaking now of schedules calling for 90 miles per hour or more) all at one date. The rate was increased, from year to year, starting about 1931. We stepped up from 60, to 70, to 80—and now we find ourselves running 90 miles per hour and more, with speeds for short distances of 115 miles per hour. In the same way our improvements of the track were made little by little—a little closer inspection of ties which were to be renewed, a little more attention to surface, gage and line—all of these becoming more important each year, until today we find our standard of track maintenance fully adequate to carry safely trains running at 90 miles per hour day after day, and with the utmost comfort.

We know that we have not built entirely new railroads to take care of this increased speed of our trains, that we are using the same railroad that has been in place a good many years, except that the weight of rail has been increased on some railroads to take care of the increased loading, and the same rule applies to ties (a better grade being applied), as well as to ballast. Otherwise, in practically all instances, the railroads are the same. No drastic reconstruction has taken place to make possible the increased speed except that a curve has been reduced here and there to increase the distance over which high sustained speed could be maintained, and that here and there a turnout has been

moved to take it out of a curve and thus improve the riding of the curve, —and this all without any great outlay of money.

The single item that has caused the greatest concern is curvature. It is obviously impossible to maintain a 90 mile per hour schedule for any great distance, if it is necessary to reduce speed to say, 40 miles on curves at frequent intervals. Therefore, it is necessary that most curves be relined and that in all cases the superelevation be increased. This element of the problem required considerable study, particularly in view of the fact that the available funds are frequently limited and it is not possible to lighten curvature on a wholesale scale. Another feature which has to be taken into consideration is the difference in speed between passenger trains and freight trains. Therefore, the existing curves must be reworked to take the maximum speed with comfort. The American Railway Engineering Association rules are generally followed in determining the proper superelevation and this has resulted in standardizing the practice on all railroads to a certain extent. Formerly, the methods of determining superelevation varied widely on different railroads, and reports received by the committee bear this out.

In addition to superelevation, the method of lining curves has received a great deal of attention. Some railroads use the stringline method, which enables a small engineering force to cover the territory quickly, while other lines do all the work with the transit. It is the opinion of the committee that the proper procedure in this work is to lay out the curve with the transit, setting permanent points for the spirals and the main curve, and thereafter maintain the curve by the stringline method.

Because the funds as well as the time for some of this work were limited, considerable lining has had to be done by the stringline method, and it is surprising what results have been obtained in the way of providing a comfortably riding track by this method. The lengths of the spirals have had to be increased and there is some variation in practice in this item, but it would appear that for speeds of 90 miles per hour on a one-degree curve, the spiral should be about 400 ft. long with 3½ in. of superelevation. Some railroads have a limiting superelevation of 6 in., while one railroad has a limiting superelevation of 4¼ in., maintaining a speed of 70 miles per hour around 2-deg. curves with 3½ in. of superelevation, and a speed of 60 miles per hour around 3-deg. curves with 4¼ in. of superelevation. As grades and physical conditions enter into this problem, each curve must be studied by itself.

Since a curve is given a specific superelevation for a definite speed, it is necessary to insure that this speed is not exceeded. This is done almost universally by providing "Reduce Speed" and "Resume Speed" signs. These signs are also used quite generally to govern speed where a reduction below normal speed is necessary at other locations, such as railroad crossings, interlocking plants, through congested territories, etc.

Preparation for Speed

Because, as mentioned above, the high speed did not come all at one time, it is difficult, if not impossible, to recount all the preparations which have been made in getting ready for the new schedules, however, it can be safely stated that no radical preparations were necessary. It is certainly impossible to determine the cost of the work. In general, it can be said that getting ready for high speeds has merely meant the tightening up of the maintenance organization in order to obtain the necessary refinement in the standards of track maintenance. To sum up the "Preparation of Track for High Speed Operation," there is really but one item which has entered into this task and that is superelevation and length of spirals; the railroad was already there.

The Twin Zephyrs of the Burlington Pass Each Other on the Route Between Chicago and the Twin Cities

Track Maintenance

As far as track maintenance for high-speed operation is concerned, it is agreed that track is more difficult to maintain now than it was five or six years ago, and it is at this point where the roadmaster becomes the important factor. Every roadmaster will bear out the conclusion that the advent of the higher-speed trains is producing more gray hairs.

He knows that surface, gage and line, not only on the curves, but on the tangents as well, require more attention than heretofore. From several sources, it develops that estimates of the increased attention necessary to insure accurate line, gage and surface run as high as 25 per cent. The roadmaster must find a way to provide this attention with smaller forces than he had six or seven years ago and with the sections lengthened.

Surface, gage and line now require greater refinement than was necessary years ago. Any imperfections in these elements must be attended to at once to provide a safe and comfortable ride, as the traveling public will become more critical as time goes on, and a rough ride is not a good advertisement. Accurate line, gage and cross surface are of course the first requisites of good track maintenance. They are increasingly important under high-speed operation. It is up to someone to see that they are properly maintained and that person is the roadmaster. High speed is causing more trouble with these items, and that means that we have to give them more attention.

It would appear that more broken rails might be expected with trains operating at greater speeds, but thus far this has not been the case. It is still too early to tell whether mechanical deterioration of crossties will be increased. Increased care in selecting ties and better treatment should more than offset any additional wear. The roadmaster must be furnished with good ties, ties that will obviate frequent renewals. Rail is another large item, but so far it has not been necessary to take out or relay rail because of high speed. In general, the high speed records are being made on rail that has been in service for some time, but the railroads, generally, have purchased considerable welding equipment to build up rail ends, turnout frogs and railroad crossings. What effect the hardening of rail ends will have time only will tell. It is somewhat too early to learn how much additional maintenance will be required on turnouts, of either the rigid or spring-rail type.

There is no apparent move to revise maintenance organizations simply because of high speed. Methods are being improved in line with the natural evolution of the industry, but as yet no radical changes can be traced to high speed alone. Roadmasters

have a problem on their hands to find ways to renew ties and conduct other general maintenance work so as not to interfere with train service and at the same time accomplish what they have set out to do in the shortest time possible. Some railroads make tie renewals with large gangs at intervals of about two or three years, giving the track a slight lift at the same time.

A roadmaster knows that it requires a good well-drained, roadbed, good ballast, good ties and good rail, with proper gage, line and surface to provide a safe and comfortable riding railroad. He knows that he cannot have this condition at all times because of the usual wear and tear. He knows that materials cost money and that it takes additional labor to apply them.

So far as working on the track or the erection of structures affecting the track is concerned, the item that causes the most concern today is slow orders. In other days slow orders of 20 to 40 miles per hour did not affect any one particularly, but now they are a real detriment, and anyone who puts up this kind of an order on a high-speed line certainly hears about it until it is taken down. It is now necessary for the roadmaster to do just a little more planning and arrange to do his work without slow orders or to keep them to an absolute minimum.

The Head End of the Mercury, the New Streamlined Steam Train of the New York Central

More work is required in the maintenance of curves than on straight track, as the centrifugal force of trains passing around the curves tends to force the weaker points out of the true circular curve, resulting in a bad riding condition. It is, therefore, very important that line stakes be set as accurately as possible to insure an accurate record of the true alinement. As the superelevation provided on any curve will produce a theoretically correct condition for only one rate of speed, care must be taken to select the most suitable superelevation for the conditions at the particular point. Should the elevation be too great, the center of gravity of the slower moving trains comes too close to the low rail and an excessive portion of the weight of the train is carried on this rail. On the other hand, if there is not sufficient elevation for the speed, the thrust of the train against the outer rail becomes excessive and gives the same feeling to a passenger that one has when riding a merry-go-round. Either condition results in excessive rail wear and shortens the life of the rail. Rail lubricators are being installed on the high rails of curves to prolong their life.

Inspections

Regular and frequent inspections must be made of the tracks and their integral parts to detect any flaws in the material or workmanship that may develop into hazards. That a high standard of materials, workmanship and inspection is maintained is reflected in the freedom from accidents that can be ascribed to defective tracks and other faults that can be avoided by proper attention to important details.

Bridges, buildings, signals and other structures form a considerable proportion of the property of a railroad, the construction and maintenance of which call for close attention not only to utility but dignified appearance as well. Safety is the primary consideration, that no accident shall occur as a result of failure of these structures. While the roadmaster may not be directly responsible for these structures, he must see that they are safe and present a neat appearance.

"Safety above everything else" guides here as it does in every phase of railroad activity. All of these facilities, adequately supervised and maintained, provide for rapid and safe transportation. Railroad maintenance is a most fascinating subject because changing conditions never allow problems to remain permanently solved.

The training of the track forces by the roadmaster becomes more important under high speed operation. It is strictly up to him to know how his gangs are behaving. He can't afford to get this information second hand from the superintendent or the division engineer. The higher the speed, the greater the hazard and the roadmaster should, first of all, develop his men to be on the alert to detect conditions in the track and other structures which will cause trouble sooner or later. He must train his men to be on the alert for defects in passing trains. It is no particular trick to know an actually dangerous condition in ties, switches, etc., but it is something else to catch this condition before it actually becomes dangerous. The roadmaster should leave no stone unturned to develop or acquire a set of foremen in whom he will have complete confidence and be assured that they will be doing the right thing at the right time. Railroads are quite generally cutting down on materials in stock and it is up to the foreman and through him, the roadmaster, to see that adequate materials are on hand when needed. This takes forethought and planning. It is also important when materials are ordered or received, that they be applied to the purpose for which they are intended with reasonable dispatch. All of us, at one time or another, have been criticized during an inspection trip because a bag of rail anchors or a pile of tie plates or angle bars was found in the bushes or under some building waiting for someone to get around to apply them. If this situation obtains after materials were ordered to correct a potentially dangerous condition, it comprises almost criminal neglect. Materials cost money; either they are needed or they are not. The more money spent on materials, the less there will be available for labor.

Facing-point switches are a necessity which nobody likes. The camlock and interlocking have done much to reduce the potential hazard they introduce, but no foreman should pass a facing point or, for that matter, any switch without giving it at least a casual inspection, and a thorough check should be made periodically. It is up to the roadmaster to see that this is done.

Slow orders have been mentioned before, but there are one or two other points regarding them that ought to be emphasized. The first is that no roadmaster should allow any slow order to stay up any longer than is absolutely necessary, and by that is meant getting rid of it within an hour after the need has disappeared. It may seem far fetched but it has been known that slow orders have remained up a day or more because somebody forgot or just didn't take them down. Gaging the exact speed for which track is safe under high speed is important. If the rails are right side up, with a few bolts here and spikes there, almost anything can get over it at 5 miles per hour, but roadmasters and others should get the highest speed possible in the face of any temporary condition, and not put on a 5-mile order merely because conditions were not right for full speed. Give the track 15, 20, 35 miles or whatever it will stand safely. This will help enginemen and dispatchers

get trains over the road. It is something that has not received the attention that it should.

Some lines are plastered with speed restrictions, many of which, when you check into them, have been on so long that nobody knows why they were put up or when. From the type of lettering on some it would appear that they had been there 50 years. There is something almost ridiculous in this situation when it is found that a roadmaster hasn't given such a sign any attention. It goes without saying that each of these signs ought to be checked. If there is a good reason for it, leave the restriction; otherwise raise it or take it down altogether. There is nothing that will cause more comment than the repeated slowing down of a train.

Accident Prevention

The safety aspect of high-speed operation, so far as the roadmaster and his forces are concerned, relates primarily to motor car operation. No one should go out on the line these days unless he has a complete lineup on trains. It is the roadmaster's responsibility to have his men properly instructed and to see that they comply with the rules.

Necessary roadway signs must be maintained, they should be legible at all times, their view not obstructed by brush and they must be so placed as to provide the greatest visibility distance possible. Highway, farm and private grade crossings must not be overlooked. They should be maintained in first-class condition to avoid an accident on either the railroad or on the highway; track men must see that flangeways are clean. Right-of-way fences must be kept in repair to keep stock off the track where it will either be struck by a train or be the cause of a needless speed reduction.

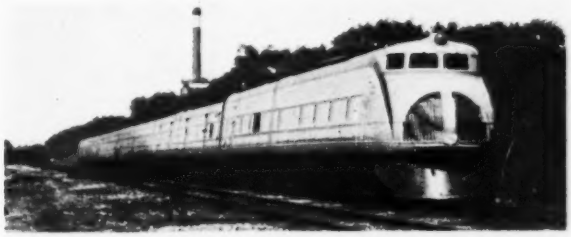
It has always been the prevailing idea that the final responsibility for track maintenance rests with the foremen. They ought to know every inch of their territories and particularly all of their shortcomings. The roadmaster can direct and supervise, but he cannot supervise every move that his men make in track maintenance. It is up to the roadmaster to get men who will be on the alert.

Higher-speed freight trains do more damage to track than high-speed passenger trains. They throw our curves out, destroy the superelevation and raise hob in general. The track structure on mixed traffic lines must be adjusted as nearly as possible to a perfect condition for both classes.

The chief drawback to the roadmaster's work on a railroad is that his territory is long, but only as wide as the right of way and he can only be in one place at a time. For that reason, and that alone, a roadmaster should see to it that his foremen are trained to accept responsibility for the territory under their supervision, and with that accomplished he will rest better at night.

Research in the maintenance of track for the new type of train is in its infancy. Only time can show what will be necessary in order to maintain the tracks so that the high-speed trains may be operated most efficiently.

Committee—Walter Lakoski (chairman), div. engr., C.M., St. P. & P., Milwaukee, Wis.; R. L. Sims (vice-chairman) dist. engr. maint., C.B. & Q., Galesburg, Ill.; A. F. Kadow, div. engr., Alton, Bloomington, Ill.; E. L. Potarf, dist. engr. maint., C.B. & Q., Omaha, Nebr.; J. H. Dunn, rdm., N.Y.C. & St. L., Ft. Wayne, Ind.; E. C. Jones, rdm, C. & N.W., Milwaukee, Wis.; R. R. Nace, chief engr. m.w., Penna., New York; J. A. Snyder, rdm., M.C., Detroit, Mich.; E. P. Safford, supvr., N.Y.C., Silver Creek, N.Y.; N. Bridges, rdm., A.T. & S.F., Newton, Kan.; M. Donahoe, div. engr., Alton, Bloomington, Ill.



One of the Streamliners of the Union Pacific

Discussion

The discussion of this report centered around the damaging effect of high-speed operation rather than the refinements in the track structure necessary to withstand the added abuse caused by such operation, and made clear that it is not so much high-speed passenger train operation that is causing maintenance men concern, as high-speed freight train operation. William Shea (C.M. St. P. & P.), citing the operation of the Hiawatha on his road, with regular operating speeds in excess of 100 m.p.h., pointed out that the locomotives of this new high-speed passenger train are specially designed for the high speeds at which they are to run, with well-distributed loads and proper counterbalancing, and, as a result, have little damaging effect upon the track, whereas, the real problem arises from the operation of heavy freight locomotives at speeds far in excess of those for which they were originally designed.

He said that he would rather have 10 Hiawathas than one heavy freight locomotive operating at speeds considerably in excess of that for which it was designed.

B. E. Haley (A.C.L.) supported by J. A. Turner (A.C.L.), told of the high-speed passenger and freight train operation on their road with standard steam locomotives and rolling stock; speeds of 70 to 90 m.p.h. for both passenger and perishable produce trains being common practice. Both agreed with Mr. Shea that the most important factor in high-speed operation, as it affects the track, whether passenger or freight trains are considered, is the proper design of the locomotives to operate at the high speeds run.

R. L. Sims (C.B. & Q.), as a result of the experience of his road with the operation of the Zephyrs, said that while refinements in the line and surface of the track were necessary for the high-speed operation of these trains, the real problem of track maintenance is caused by the stepping up of freight train schedules which the faster passenger train movements have, in part, brought about.

Mr. Haley admonished the members of the association to be prepared to meet the demands on the track of high-speed freight train operation, predicting that the future will see accelerated freight train speeds, with maximum speeds beyond that being attained on most roads at the present time.

President Chinn pointed out that high-speed operation usually requires certain refinements in track maintenance, with closer supervision to produce safe and comfortable riding conditions, but that the track structure itself apparently requires no fundamental strengthening or change in design to carry this accelerated traffic. He also agreed with the other members entering the discussion, that it appears that the real fear of track damage is not in the high-speed operation of well-designed passenger equipment, but in the operation of standard freight equipment at speeds considerably in excess of that for which it was originally designed.

The Use of Work Equipment
to Secure the Greatest Economy in Track Maintenance

Report of Committee

THE Use of Work Equipment to Secure the Greatest Economy in Track Maintenance is a subject to which a great deal of time and study are being given by maintenance officers. The last five years have done more to bring the use of work equipment before maintenance men than any other like period. The railroads were faced with an appalling decrease in revenues. At the same time increased demands were made on the track structure, as it was required to provide for increased speeds and heavier wheel loads without any impairment of safety. This demand had to be met with a minimum outlay and it must be said of those who design work equipment that they were not found wanting, for through their cooperation with various roads and through a period of experimentation we have machines today that are adapted to nearly every type of maintenance work. It has been estimated that in 1935 the railroads of the United States and Canada had a total of $100,000,000 invested in work equipment.

R. W. Grigg
Chairman

Laying Rail

Great economies have been effected through the use of work equipment in laying rail. The number of different operations involved offers a wide field for the use of power tools. Our old hand methods of laying rail seem crude compared with the completely mechanized rail laying procedure that is employed today on many roads. The committee finds that the types of machines and the number of units used by roads that have mechanized their rail laying gangs vary but little on different roads.

One western road, in laying rail, uses two mechanical spike pullers, three adzers, one light crane to lay rail, one air compressor serving two to six spiking hammers, one air compressor serving two to four pneumatic wrenches, and two light cranes, with a work train to load the released material. (One of these cranes is equipped with a magnet for handling small material). This particular road follows its rail laying operation with three ballasting gangs of from 45 to 50 men each. These gangs each use a power jack and a 16-unit pneumatic tamper. The cost of laying rail on this railroad was reduced from $2,960 per mile in 1925 to $1,757 per mile in 1934, a saving of 40 per cent that was accomplished through the use of power equipment.

Similar economies have been affected on one of the larger eastern roads. Practically the same set-up was provided except that engine-driven wrenches were used in place of the pneumatic wrenches, and two power rail drills and two power bonding drills were provided. Crawler-type cranes, running through the cars, were used for unloading and loading the rail, and one locomotive crane equipped with a magnet was used with the work trains for handling the small material. A saving of 40 per cent, compared with the cost of the old hand method, was effected on this road. New rail was laid at a saving of $2.85 per ton which, for the 59,020 tons laid, amounted to $168,200.

Table I shows the results of time studies on laying rail, submitted by an eastern road. These figures show the unit cost per foot and the equipment used on each job.

Considerable saving can be effected in territory where rail is transposed on curves or where relayer rail is laid without disturbing the tie plates by using a locomotive crane, one or two power wrenches, and two mechanical spike pullers. This equipment was an important factor in getting the work done with about half the force required to do the job by hand. A breakdown of the cost of laying rail by machinery, as compared with manual methods, on a large eastern road is given in Table 2.

Economy in track maintenance involves more than merely the actual dollars saved on a particular operation. The quality of work must be considered, and we get a much better and quicker job by laying rail with work equipment. Regardless of how careful a man is in adzing a tie, his work is not nearly as uniform as that done with a power adzer. This also is true in spiking. Then too, there is no possibility of rail being damaged by a careless spiker. The power wrench gives a more uniform and speedier job of bolt tightening. A crane equipped with a magnet makes the loading of tie plates and other small material a very simple matter in cleaning up after a rail job.

Aside from these advantages and economies, the use of work equipment in laying rail has greatly reduced the number of accidents. Laying rail has always been a hazardous undertaking, but with the use of cranes and other labor-saving devices the number of men required to per-

Table I—Cost of Rail Laying

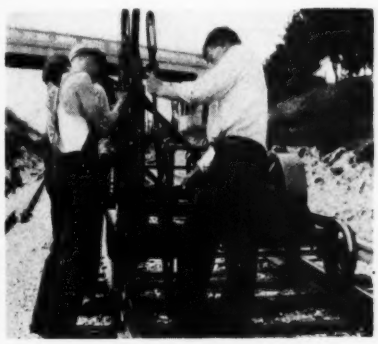
Weight of rail and equipment used	Cost Per Lin. Foot	Remarks
130-lb. rail replacing 100-lb. rail, no machinery used	$0.0785	Double track, tie plated, heavy traffic
110-rail replacing 100-lb. rail, using one crane	0.0643	Single track, tie plated, light traffic
110-lb. rail replacing 100-lb. rail, using one crane, four spike hammers, four power wrenches	0.0568	Double track, tie plated, heavy traffic
130-lb. rail replacing 100-lb. rail, using one crane, two spike pullers, three adzing machines, four spike hammers, four power wrenches	0.069	Double track, tie plated, mountainous territory, heavy traffic
130-lb. rail replacing 130-lb. rail, using one crane, two spike pullers, three adzing machines, four spike hammers, four power wrenches, one gaging tool	0.0510	Multiple track, tie plated, heavy traffic

Table 2—Unit Costs in Rail Laying

Class of Work	Cost by Machinery	Cost by Hand
Adzing ties	$0.0023 per tie	$0.007 per tie
Cranes, setting in rail	0.08 per rail	0.20 per rail
Drill, power bonding	0.02 per ¾-in. hole	0.05 per ¾-in. hole
Drill, power rail	0.10 per 1⅛-in. hole	0.30 per 1⅛-in. hole
Nut machine, power	0.0125 per bolt	0.0375 per bolt
Nut machine, power	0.0077 per bolt	0.0375 per bolt
Saw, power rail	0.77 per cut	1.35 per cut
Spike driver, pneumatic	0.005 per spike	0.0075 per spike
Spike puller, mechanical	0.0025 per spike	0.00375 per spike
Rail layer, power	0.0573 per rail	0.20 per rail

form the work has been greatly reduced and this has been followed by a proportionate reduction in accidents.

New types of work equipment and improvements in old units are constantly being made. These improvements result in further reductions in the number of men required to lay rail. For instance, the following is a



The Spike Puller Is An Aid to Efficient Rail Laying

comparison of the number of men employed by one road in fully mechanized rail gangs, doing identically the same work in 1927 and 1935, as shown in the March, 1936, issue of *Railway Engineering and Maintenance*.

	1927	1935	Difference
Preparatory work	91	38	—53
Setting in rail	6	5	— 1
Joints	19	9	—10
Spiking	45	33	—12
Signal gang	3	6	+ 3
Miscellaneous	2	5	+ 3
Work Trains	15	18	+ 3
Supervision	4	6	+ 2
Total	185	120	—65

Cleaning Ballast

The last five years have seen a rapid development in the method of cleaning ballast. Clean, ballast is a prerequisite of good drainage, which in turn is essential to economical track maintenance. A very thorough and detailed report on Methods of Cleaning Ballast was presented at the forty-ninth annual convention of this association, and what follows is offered as supplementing that report.

Hand cleaning of ballast is a slow and costly operation. With the introduction of ballast cleaning equipment, the number of miles of ballast cleaned has increased rapidly. The figures below are an average of those submitted by a number of larger roads on the cost of cleaning ballast.

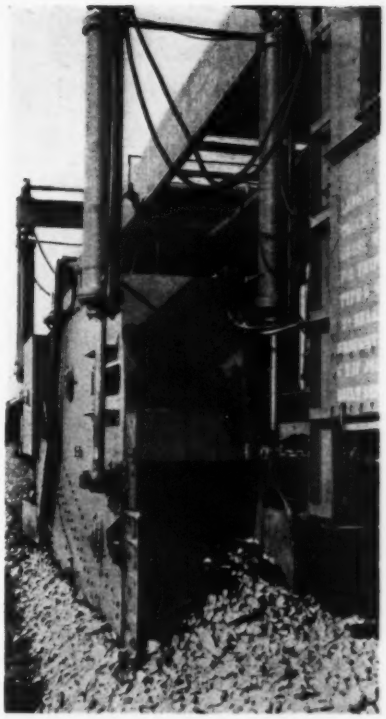
Method	Cost per Lin. Foot
Hand shaking	$0.20
Hand screens	0.13
Locomotive crane (one with screen)	0.054
Locomotive crane (multiples of three)	0.036
Mole cleaning	0.052 intertrack 0.045 shoulder
No. 1 Ballast Cleaner (rental basis)	0.0528 intertrack 0.026 shoulder
No. 2 Ballast Cleaner (rental basis)	0.0534

The mole, either intertrack or shoulder, is a very efficient and economical device for cleaning ballast. It is especially well suited for locations where traffic is dense and the total track occupancy for an eight-hour shift is a minimum. From reports on mole cleaning submitted by a number of roads using this machine, we find that the intertrack mole will clean from 700 to 950 ft. of intertrack space per eight-hour shift and the shoulder mole will clean from 600 to 900 ft. of shoulder per eight-hour shift.

An average of 7,456 ft. of intertrack space cleaned per eight-hour shift is reported by one of the eastern roads, which has used the No. 2 ballast cleaner. This same road has used the No. 1 ballast cleaner for several seasons. An average of 11,473 ft. of intertrack space and 2,815 ft. of shoulder or a total of 14,288 ft. was cleaned per eight-hour shift.

Through the use of ballast-cleaning equipment a greater number of feet of track can be cleaned each season, at a saving of more than 50 per cent compared with the cost of hand cleaning and a more satisfactory job is obtained. Machine cleaning results in a more uniform subgrade below the cleaned ballast, which thus parallels the existing grade of the tracks, affording much better drainage than the rough subsurface left by hand cleaning. The depth below the top of tie can be increased or decreased as desired without materially affecting the number of feet cleaned per shift.

Many types of machines are in use today for tamping track and the cost



One Type of Ballast Cleaner

of tamping is being reduced through the design of more flexible types of power units. Pneumatic and electric hammer-blow tamping equipment has been used with success for some time. Although material savings have been effected through the use of mechanical tamping, even greater savings are becoming apparent with the introduction of crawler-type power units. They eliminate the expense involved in handling from 1,800 to 2,000 ft. of pipe line and of moving the compressor ahead each time the end of the line is reached. Similar savings are to be expected with the use of the crawler type power unit in electric tamping. A more recent development is a self-contained, gasoline engine tamper unit. This new tamper is readily portable and, so far, has given satisfactory service.

Reports from several roads show that from 585 to 900 ft. of track can be tamped per day with pneumatic tampers. The costs ranged from 10 to 14 cents per foot of track tamped. From 350 to 600 ft. of track can be tamped per day with electric tampers, according to reports received from several roads. The cost of the electric tamping varied from 7 to 9 cents per foot.

It has been proved that track which has been mechanically tamped holds up and rides better than hand-tamped track. This is due largely to the more uniform job of tamping done. It has also been noticed that the undersides

of the crossties are not damaged or "cupped" out as they are when repeatedly hand tamped. Loose ties are at a minimum when mechanical tamping is done.

A number of mechanical tamping outfits are available for tamping track in cinder or gravel ballast. One of these, the power ballaster, is used rather extensively. This machine embodies a heavy crosshead or frame that moves in vertical guides and has shoes fastened to its lower side. With the machine spotted over the tie crib, this frame is raised to a certain height and then dropped, forcing the shoes under the two adjacent ties. This machine produces a uniform and compact job of tamping and has proved economical in cinder and gravel ballast and especially when used with a power jack. One road that used two of these machines in cinder track reports a saving of 50 per cent as compared with hand tamping. Electric vibratory tampers have been used in cinder and gravel ballast for some time and have proved an economical means of tamping track of this kind.

Through the design of smaller and more flexible types of power units mechanical tamping is becoming more adaptable for spot surfacing. Savings corresponding to those effected through the use of mechanical tamping in out-of face raising can be expected from the use of similar equipment in spot surfacing. A discussion of the various types of machines used in tamping track and the organization used with each was presented at the last convention by the Committee on Ballasting and Resurfacing Track —Equipment, Organization and Methods.

The cost of unloading stone and gravel ballast has been reduced from 30 to 40 per cent through the use of special ballast cars. That this saving has more than justified the use of these cars is apparent when we consider the large quantity of ballast, both stone and gravel, that is used each year in regular maintenance work. There are several makes of such cars on the market today, and many roads have remodeled cars in their own shops to obtain a more uniform and rapid unloading of ballast. Unloading ballast necessitates either work-train or local-freight service, and the quicker the cars are unloaded the lower the cost. This is not the only factor involved, as the ballast has to be dressed by hand and a uniform distribution reduces the cost of dressing. These ballast cars result in savings in handling the ballast and in the quantity of ballast used. Table 4 gives comparative figures derived from a time study of the operations of unloading ballast from a standard hopper car and a special ballast car.

Table 3—Comparison of Mechanical Tamping with Hand Tamping

Submitted by a Large Eastern Road
Two-inch Lift on New Rail, Stone Ballast

A. Machine Tamping: cribs ½ to ¾ full

	Eight Faces		Six Faces	
Operation	Man-Hr. per Ft.	Cost per Ft.	Man-Hr. per Ft.	Cost per Ft.
Jacking track	0.005	$0.002	0.005	$0.002
Running level board	0.002	0.001	0.002	0.001
Cribbing out ballast	0.013	0.005	0.013	0.005
Tamping	0.126	0.055	0.098	0.042
Replacing and dressing	0.025	0.010	0.026	0.011
Compressor operator	0.016	0.006	0.016	0.007
Flagman	0.016	0.006	0.016	0.007
Foreman	0.016	0.006	0.016	0.007
Total	0.219	$0.091	0.192	$0.080

B. Hand Tamping, cribs ½ to ¾ full

	Eight Faces		Six Faces	
Operation	Man-Hr. per Ft.	Cost per Ft.	Man-Hr. per Ft.	Cost per Ft.
Jacking track	0.005	$0.002	0.006	$0.002
Running level board	0.002	0.001	0.002	0.001
Cribbing out ballast	0.019	0.007	0.020	0.008
Tamping	0.161	0.065	0.147	0.059
Replacing and dressing	0.031	0.012	0.034	0.013
Flagman	0.024	0.010	0.027	0.011
Foreman	0.024	0.010	0.027	0.011
Total	0.265	$0.106	0.263	$0.105

Table 4—Study of Ballast Unloading Costs

Unloading Stone Ballast, Per Car
100,000 to 140,000 capacity

	Hopper Cars		Special Ballast Car	
Operation	Man-hours per car	Cost per car	Man-hours per car	Cost per car
Unloading	2.759	$1.123	1.612	$0.656
Cutting out ballast with ballast shoe	0.663	0.270	0.388	0.158
Foreman	0.361	0.147	0.21	0.086
Total	3.783	$1.54	2.211	$0.90

Unloading Gravel, Per Car
100,000 to 140,000 capacity

	Hopper Cars		Special Ballast Car	
Operation	Man-hours per car	Cost per car	Man-hours per car	Cost per car
Unloading	1.393	$0.567	0.813	$0.331
Cutting out ballast with ballast shoe	0.516	0.210	0.302	0.123
Foreman	0.155	0.063	0.088	0.036
Total	2.064	$0.840	1.203	$0.490

Drainage

Faster schedules and heavier trains have called for a correspondingly greater degree of refinement in track surface. Good drainage has always been necessary for good track, and ditching is one means of securing good drainage. Our ditching program today is far broader than it was years ago. We are now better equipped to do this work.

Ditching in the days of the pick and shovel was a slow and laborious task. Today we use steam ditchers (both bucket and dipper), gasoline ditchers (both rail and crawler-mounted), the spreader, the gasoline drag-line and the bulldozer. The cost per cubic yard of ditching with such equipment has been reduced further through the use of special dump cars. The locomotive crane with several dump cars comprises an economical means of ditching in and around yards and terminals. The crane can be used to good advantage in conjunction with a ditching train. It can be detached and operated as a separate unit for ditching in small cuts in close proximity to the ditcher train.

An eastern road, in co-operation with a manufacturer of dump cars, perfected a drop-end dump car that reduced the cost of ditching considerably. A crawler-type shovel was mounted on a flat car with a drop-end dump car on each side of it, and an ordinary dump car was added to each end of this three-car unit. The shovel ran through the drop-end dump, loaded the regular dump car, backed out on the flat car, and loaded the drop-end car, after which the same

operation was repeated from the other end. It was found that with this set-up the time required to run to and from the place of dumping was reduced 50 per cent.

Recently there has been made available a front-end loading crawler-type excavator that is adaptable for ditch digging and cleaning in cuts of medium length where the quantity of work necessary is not sufficient to justify the use of ditcher trains and the fills at the end of the cuts are too wide for dumping from cars. Below is a tabulation of the cost per cubic yard of ditching with various types of machines as compared with hand ditching. These represent the range of costs submitted by four of the larger roads.

	Cost per Cubic Yard
Hand operations	$0.40 to $0.75
Steam ditcher	0.307
Gas ditcher operated with drop-end dump and ordinary dump cars	0.247
Front-end loading crawler-type excavator	0.20 to 0.25
Gas ditcher with drag-line	0.1042
Spreader	0.05 to 0.10*

*Equals about 2.67 cents per lineal foot

A number of roads have found that marked savings have been effected by using work equipment in drainage projects involving the installation of drain pipes. With regard to this, a maintenance officer of one of the western roads writes as follows:

"Last season on a tile drain project we estimated the cost very closely, based on our experience in excavating the side and lateral ditches with a pick and shovel gang. After careful consideration we decided to provide two air compressors with the necessary pneumatic tools, clay spaders, jack hammers, paving breakers, etc., to speed up the work. We found when finished, that a more satisfactory job had been secured and a savings of $2,000 had been effected. This was a savings of approximately one-fourth the original estimate."

The cost of rail is one of the biggest items in track maintenance today. Any operation whereby the life of rail in track can be lengthened affords real economy. The process of reconditioning rail through the use of electric-arc and gas welding has progressed rapidly with the adoption of the portable grinder. Almost every reply received in answer to the question "How have economies in track maintenance been effected by the use of work equipment?" stressed rail-end welding. In the words of the chief engineer of one of the larger railroads —"On the ———— railway during the trying times of the past few years the greatest single economy in track maintenance, made possible by the use of work equipment, has resulted from rail-end welding. By the periodic building up of rail ends, it is estimated that the life of new rail on tangent in its first location can be at least doubled. Our welding has also extended to diamond crossings, frogs, switches, and splice bars. Prior to the introduction of welding many renewal crossings had to be provided each year, while now a renewal is a rarity."

One of the southwestern roads reports a cost of 72.6 cents per joint for reconditioning rail ends over a period of a year. This operation consists of electric arc welding, grinding with grinding wheels, and cross grinding with a hand electric grinder. An average of 40 joints were reconditioned per day per man. Another road reports that over a period of 10 years the cost of reclaiming by gas welding averages 10 cents per lineal inch. The arc welding of manganese crossings and frogs in track has resulted in a material decrease in maintenance costs. This process has proved more flexible than the removal of frogs from track for repairs.

Grinders

The life of rail has been increased through the use of surface grinders of both the wheel and reciprocating types. Cross grinders have also been perfected for grinding or slotting rail joints. The cost of this operation is given as 1.6 cents per joint. This is a marked saving compared with the old hand file method of beveling rail joints. Cross grinding prolongs the life of rail because it prevents the chipping of rail ends, which unless it is corrected, will cause the rail to batter. Poor joint conditions greatly increase the cost of surfacing. Track with defective joints will not hold up unless the rail is reconditioned or renewed. One road surface-ground its rail with a reciprocating grinder at a total cost of 9 cents per joint. One of the eastern roads reconditioned 17,991 joints at a total cost of 19.2 cents per joint by using five high-speed rotary grinders, two cross grinders and two gas welders. Only 12 per cent of the 17,991 joints that were reconditioned required welding. Corrugated rail was also treated with this type of grinder, the corrugations being removed successfully. This work was done at a cost of 4.82 cents per foot of track, or 2.41 cents per foot of rail, using four grinders.

There are many portable grinders which may be used to a great advantage in track maintenance. These grinders provide the means for obtaining large savings in reconditioning switch points, stock rails, and frogs. It is possible to recondition a switch (including stock rails and switch points) with one of these grinders at a cost of $1.15 per switch. The renewal of stock rails and switch points can be reduced to a minimum through the use of a portable grinder.

Motor Trucks

In territory where roads or streets parallel the tracks, odd jobs such as the trucking of material, the repair of crossings, digging small ditches, the handling of men and material in cases of emergency, etc., justify the use of a truck. Each supervisor on a main-line division of a large eastern road has a 1½ to 2-ton truck. These trucks transport men to and from work when special work is being done, thus greatly reducing the travel time. These trucks keep the machines supplied with gas, oil and supplies, and are also employed for small jobs that would otherwise have required a work train or motor cars.

Welding Plays an Important Part in Track Maintenance

This road has recently purchased two rail-highway cars that operate either on the track or the highway. They completely fulfill the service of a section motor car and also function satisfactorily and with added flexibility as the one and two-man cars. Another point in favor of these rail-highway cars is that they can be moved to and from the rail or highway by one man under any load that does not exceed their rated capacity. These cars can be used by supervisory and division officers in inspections and in covering remote lines of thin service. They take the place of highway vehicles and keep the supervisory forces on the railroad.

Fighting Snow

Work equipment has proved useful in such emergencies as fighting snow and combating floods and dust

storms. The last winter saw every available piece of snow-fighting equipment taxed to its utmost. Snow plows of both the push and rotary types, together with the spreader, have proved to be both labor and time savers in combating snow drifts. Gas and steam ditchers have been used to advantage in loading the snow out of cuts and from yards and terminals in many places. The spreader has been used effectively for cutting ice from between the rails in the vicinity of track pans. Air tamping outfits using special cutting points have also been used with good results in this work. A number of locomotives on one of the eastern roads are equipped with steam snow blowers for melting snow and ice, doing away with expensive manual methods.

Switch Heaters

A number of switch-heating devices are available. One of these is the electric switch heater, but in most locations the cost of operation is almost prohibitive. Steam heaters are economical where there is a convenient supply of steam, and are therefore most adaptable in and around large terminals. Gas burners are very effective and are best suited to locations where gas is available and the rates are not prohibitive. One heating system embraces the use of an air compressor and an elaborate pipe layout to a number of switches. This system uses a high-grade of carbon oil and operates on the same principle as a blow torch. This is probably the most flexible of all switch heating systems as it is adaptable to almost any location. This type of heater can be kept burning indefinitely, and if the burners are properly adjusted they will not seriously damage the rail. There are also several portable types of heaters on the market. One of these is an evolution of the old snow-melting pot. It holds more fuel, the flame can be adjusted, and it is economical and efficient. Several makes of torches are quite effective in opening up switches that have been snowed up or frozen.

Removing Dust and Dirt

Work equipment has been almost a necessity in combating the dust storms of the last few years. The spreader and various other types of machines have been used to great advantage for removing the sand and dirt from the roadway. A large eastern road has developed two different types of machines for removing front-end cinders from the tracks in mountainous territory. One of these machines is a sweeper that is pulled by a locomotive. A revolving broom with steel wire brushes sweeps the cinder onto an endless belt which deposits them in a bin. The other machine is a sucker, the cinders being loosened by agitation with two or more steam jets, and then sucked up and dropped in a hopper. The necessary vacuum is created by steam furnished by the work-train engine. The machines have been used extensively and have proved quite satisfactory. They might be used for removing dirt and sand from the tracks in dust storm areas, but we have no knowledge of their use for this purpose.

Floods

Possibly no greater emergency in the routine operation of a railroad arises than that occasioned by a flood. The damage done in times of serious floods gives rise to prompt reconstruction work which in most cases means the rebuilding of roadbed, bridges and other facilities. The floods of the last spring in the east practically paralyzed the railroads. Tracks were completely washed away and bridges and station facilities were damaged if not entirely destroyed. In such emergencies every available piece of work equipment that can be used must be mustered into service.

Grinders Have Come Into Common Use

On one of the large eastern roads that suffered most severely from the flood every crane within reach was placed in service loading filling material, bridge timber, and other much needed supplies. Other cranes were used at the scene of the disaster for removing debris, opening up ditches, filling in around the approaches to bridges and erecting temporary trestles. Dump cars facilitated the building of banks. Spreaders were then pressed into service. Air compressors were a great help in erecting temporary trestles, saving much time through the use of pneumatic saws for cutting off piling and framing trestle bents. The same compressors also operated other pneumatic tools. Generators for electric tie-tamper outfits were used to provide current for lights that were strung around bridge sites so that work could be done as easily by night as by day. After the roadbed had been restored and work trains could get through, cranes of all types were used for reclaiming the tracks, which in many cases had been washed off the banks.

Conclusion

In the foregoing discussion we have not attempted to present a study of the economical use of work equipment, the purpose being rather to show the unlimited possibilities of effecting economies in track maintenance through its use. Economies in maintenance have been obtained with work equipment in the following ways.

1. Quality of work performed—the quality of work performed by work equipment equals and in many cases surpasses that done by hand methods.
2. Quantity of work done—A maximum amount of work is accomplished in a minimum length of time. Production in many cases has been doubled.
3. Flexibility in use of machines—Work that was formerly thought impossible in the field has become routine maintenance work. The life of rail, frogs and switches has been greatly increased.
4. Reduction in force—Less men are required to perform more work.

We are of the opinion that even greater economies can be effected in track maintenance through the proper selection and programming of work equipment. We recommend the use of work equipment in track maintenance wherever its use is adaptable as a means towards maintenance economy.

Committee: R. W. Grigg (chairman), supervisor, Penna., Orrville, Ohio; G. E. Boyd (vice-chairman), associate editor, *Railway Engineering and Maintenance*, Chicago; A. W. Wehner, roadmaster, S.P., Lake Charles, La.; P. Chicoine, roadmaster, C.P.R., Vandreuil, Que.; E. L. Banion, roadmaster, A.T. & S.F., Independence, Kan.; J. Morgan, supervisor, C. of Ga., Leeds, Ala.; B. K. Shatto, supervisor, B. & O., Willard, Ohio; William Hogan, supervisor, B. & O.C.T., Chicago; J. R. Kanan, roadmaster, C.B. & Q., Hannibal, Mo.; B. C. Dougherty, roadmaster, C.M. St. P. & P., Chicago; F. L. McMillan, supervisor, Alton, Joliet, Ill.; W. A. Moberly, roadmaster, C.M. St. P. & P., Chicago.

Discussion

William Shea (C.M. St. P. & P.) stated that as a result of the use of large thoroughly-mechanized gangs for major maintenance tasks on his road the cost of labor had been reduced to 35 per cent of the total cost

of the work, leaving 65 per cent for materials. Referring to that portion of the report dealing with the transposition of rails on curves, M. Donahoe (Alton) said that he had been able to do such work economically with hand labor. Mr. Grigg replied that in transposing rail on curves he had effected considerable savings through the use of a rail crane and spike pullers. In answer to a question by E. E. Crowley (D. & H.), Mr. Donahoe said that when transposing rail on short curves he uses a gang composed of a foreman and 25 men or less.

C. R. Knowles (I.C.) complimented the committee on the cost figures which it had presented and also declared that he was in complete agreement with the conclusions presented at the end of the report, particularly the first one. The use of work equipment, he said, results in a higher quality of work and a more uniform output.

Answering a question by F. B. LaFleur (S.P.), Mr. Grigg said that the cost figures given in the tables include only operating costs and do not include such items as depreciation, interest on the investment and the cost of maintaining the machines while they are idle. W. W. Miller (West. Md.) asked if the figures given in the report on the cost of cleaning ballast include the cleaning of the cribs. Mr. Grigg's reply was in the negative.

C. W. Baldridge (A.T. & S.F.) stressed the importance of keeping work equipment in use as much of the time as possible, stating that in some instances certain pieces of equipment are used only three months of the year. Mr. Shea said that he did not favor the use of dual-purpose equipment, explaining that gangs on his road are so equipped and organized that each piece of equipment is kept busy during the entire time that the gang is working. Answering a question put by Mr. Crowley concerning the maintenance and repair of equipment on the job, Mr. Shea said that each gang is supplied with a supervisor of machines whose duty it is to keep the equipment in working order.

Because of the necessity for taking heavy equipment to sidings to permit the passage of trains, R. W. Davis (N.P.) was of the opinion that the extent to which large thoroughly-mechanized gangs may be used on single track lines depends to a large extent on the amount of traffic. Mr. Shea replied that his road uses large gangs extensively on single track lines without encountering insurmountable obstacles.

Referring to Mr. Shea's remark that he did not favor the use of dual-purpose equipment, Mr. Chinn pointed out that on small lines it is necessary to use equipment that may be adapted to various uses. Otherwise, he said, the railroad would have on its hands equipment that would be in use only a small percentage of the time.

Pointing to the fact that the Committee on Maintenance of Way Work Equipment of the American Railway Engineering Association was present during the presentation of this report, E. T. Howson *(Railway Engineering and Maintenance)* said that the Roadmasters Association should consider it a compliment that this committee thought sufficiently of the report to schedule its meeting so that it would coincide with the convention. He prophesied that the developments in the design of work equipment that have taken place in recent years are only a forerunner of more important developments in the future. As maintenance men become more machine-minded, he said, they will have a tendency to develop more uses for power equipment.

The Track Supply Exhibit

WHILE by no means as old an institution as the Roadmasters' Association, the Track Supply Association has come to be recognized as an established auxiliary to the older organization. In fact, the Track Supply Association has presented an exhibit at each convention of the Roadmasters' Association since 1911, and it is not going too far to say that the exhibit has been an important element in insuring the success of the conventions. As is well known, a considerable number of officers in charge of track maintenance who are not members of the Roadmasters' Association, make it a point to be in Chicago at the time of the convention in order that they may make a careful examination of the exhibit.

Frank J. Reagan
President

This year 45 companies presented exhibits of materials and equipment used in the construction and maintenance of railroad track, as compared with 40 in 1935 and 38 in 1934.

The officers of the Track Supply Association, who were responsible for the preparation and conduct of the exhibit this year were: President, Frank J. Reagan, American Fork & Hoe Company, Chicago; vice-presidents, H. H. Talboys, Nordberg Manufacturing Company, Milwaukee, Wis., and Jess Mossgrove, Austin-Western Road Machinery Company, Aurora, Ill.; secretary-treasurer, Dan J. Higgins, Gardner-Denver Company, Chicago; directors, George T. Willard, P. & M. Company, Chicago; Lewis Thomas, Q. & C. Company, Chicago; Lem Adams, Oxweld Service Company, Chicago; R. J. Platt, Sellers Manufacturing Company, Chicago; E. E. Thulin, Duff-Norton Manufacturing Company, Chicago; R. J. McComb, Woodings Verona Tool Works, Chi-

Dan J. Higgins
Secretary-Treasurer

cago; and K. K. Cavins, Fairmont Railway Motors, Inc., Chicago.

At the election of officers Mr. Talboys was advanced to president; Mr. Mossgrove was elected first vice-president and Mr. Adams, second vice-president; Mr. Higgins was re-elected secretary-treasurer; and the following were elected to the board of directors: For one year to complete the unexpired term of Mr. Adams, Mr. McComb; for the two-year term, J. E. Mahoney, P. & M. Company, Chicago, E. C. Argust, Morden Frog & Crossing Works, Chicago, and F. W. Anderson, Northwestern Motor Company, Eau Claire, Wis.

List of Exhibitors

Air Reduction Sales Company, New York; welding and cutting equipment; oxygen and acetylene regulators; carbide lights, lamps and lanters; carbide; welding rods, goggles, built-up and heat-treated rail joints; J. F. Callahan, C. A. Daley, J. T. Gillespie, R. C. Holcomb, J. W. Kenefic, B. N. Law, L. C. McDowell, R. T. Peabody, U. F. Portel, E. F. Turner and M. M. Weist.

American Fork & Hoe Company, Cleveland, Ohio; rail anchors, tapered rail-joint shims, shovels, weed cutters, forks, rakes, scuffle hoes and broom rakes; H. C. Branahl, G. L. Dunn, S. L. Henderson, C. E. Irwin, T. A. Lawson, J. J. Nolan, Frank J. Reagan and F. C. Stowell.

American Hoist & Derrick Company, St. Paul, Minn.; photographs of work equipment; J. L. Hickey, Ward B. Maurer and Harold O. Washburn.

Austin-Western Road Machinery Company, Aurora, Ill.; models and moving pictures, and literature on air dump cars and power shovels; H. F. Barrows, J. D. Benbow, H. B. Bushnell, Jess Mossgrove, Bruce Smith and A. O. Teckemyer.

Barco Manufacturing Company, Chicago; gasoline tie tampers, stoves, sand dryers, and flexible ball joints; F. N. Bard, W. J. Belhke, C. O. Jenista, L. J. Lytle and C. L. Mellor.

Buda Company, Harvey, Ill.; light section motor car, inspection motor car, extra-gang motor car, mechanical tie tamper, electric tie tamper, switch stand, bonding drill, track liners, rail bender, journal jacks, track jacks, tool grinder and tie spacers; H. C. Beebe, R. M. Blackburn, H. S. Brown, R. B. Fisher and G. A. Secor.

Caterpillar Tractor Company, Peoria, Ill.; Diesel tractor; G. A. W. Bell, Jr., J. H. Fitzgerald, H. M. Hale, W. A. Harding, Eugene Larsen, C. A. Spears and A. C. Thompson.

Chipman Chemical Company, Inc., Bound Brook, N.J.; J. K. Aiman and I. J. Strain.

Creepcheck Company, Inc., Chicago; rail anchors; T. D. Crowley, R. R. Dinklage and N. A. Howell.

Crerar Adams & Company, Chicago; track drills, tie bander, wrenches and rust-proof paint; Virgil Cunningham, George J. Doyle, Adolph Hawkinson, Edward C. Poehler, Irving E. Poehler, J. M. Temple and Thomas F. Tough.

Cullen-Friestedt Company, Chicago; motion pictures; W. C. Bamber, L. B. Bertau, C. J. Bronez, E. V. Cullen, F. J. Cullen, F. P. Cullen, C. H. Goodell and J. F. Leonard.

de Sanno & Son, A. P., Philadelphia, Pa.; radial grinding wheels; L. E. Buckingham, J. C. Rinehart, E. J. Bohan and W. K. Whelan.

Duff-Norton Manufacturing Company, Pittsburgh, Pa.; track jacks, power jacks, journal jacks, automatic lowering jacks and tie spacers; Dave Evans, W. F. Floyd, J. J. Gilchrist, G. C. Hutchinson, Jr., G. L. Mayer, A. Roberts, C. N. Thulin and E. E. Thulin.

Electric Tamper & Equipment Company, Ludington, Mich.; universal tamper, ballasting and tamping blades and tips, and concrete vibrator; V. G. Cartier, H. W. Cutshall, C. Jackson, G. W. Walters and J. M. Webb.

Fairmont Railway Motors, Inc., Fairmont, Minn.; inspection car, section car and heavy-duty motor car; C. P. Benning, W. D. Brooks, Kenneth Cavins, C. J. Dammann, Arthur R. Fletcher, C. H. Johnson, W. F. Kasper, J. T. McMahon, V. Pagett, J. E. Simkins, H. A. Sly and Wm. Williamson.

Hayes Track Appliance Company, Richmond, Ind., bumping posts, wheel stops and portable derail; S. W. Hayes, Herbert J. Mayer and Paul C. McClure.

Hubbard & Company, Pittsburgh, Pa.; track tools, alloy track chisels, spike mauls, sledges, picks, wrenches, claw bars and adzes; J. S. Wincrantz.

Illinois Malleable Iron Company, Railroad division, Chicago; rail anchors; Chas. G. Ericson, W. T. Kelly and H. A. Morean.

Ingersoll-Rand Company, New York, N.Y.; pneumatic tie tamper, track wrench, rail drill, spike driver, screw-spike, wrench and clamp bolt wrench; W. H. Armstrong, G. E. Bridge, G. W. Morrow and T. H. Weigand.

O. F. Jordan, East Chicago, Ind.; model of spreader ditcher; A. W. Banton, J. C. Forbes and H. M. McFarland.

Kalamazoo Railway Supply Company, Kalamazoo, Mich.; one-man inspection car, light section motor car, motor-car engine, motor-car wheels, track gage and level; L. W. Bates, Ralph E. Keller, Frank E. McAllister and P. J. Robischung.

Keystone Grinder & Manufacturing Company, Pittsburgh, Pa.; track grinder, cross grinder and hand grinder and attachments; L. J. Cooney, A. P. Grenier, C. D. Hicks, J. M. Moore and Wm. Newman.

Lundie Engineering Corporation, New York; tie plates and rail lubricator; L. B. Armstrong and O. W. Youngquist.

Maintenance Equipment Company, Chicago; switch point protector, rail and flange lubricator, derail, and literature on rail layer and switch point protector; D. M. Clarke, E. Overmier, T. E. Rodman, R. J. Shanahan and P. A. Wells.

Mall Tool Company, Chicago; portable rail grinders and flexible-shaft cross-grinding; M. Elrick, A. W. Mall, F. A. McGonigle and J. G. Sheppard.

Morden Frog & Crossing Works, Chicago; heat-treated forged compromise joints, adjustable rail braces and miscellaneous forged fittings for switches; E. C. Argust, W. Homer Hartz, G. F. Killmer, L. I. Martin and Sam Withrow.

Nordberg Manufacturing Company, Milwaukee, Wis.; rail grinders, track power drill, power track wrench, utility rail grinders and accessories; C. P. Clemmens, W. W. Fitzpatrick, C. K. Jensch and H. H. Talboys.

Northwestern Motor Company, Eau Claire, Wis.; hump and extra-gang car, section car and inspection motor car; motor car wheels, rail and frog surface grinder; F. W. Anderson, Otis B. Duncan, G. H. Goodell, A. H. Nelson, W. J. Roehl and W. J. Roehl, Jr.

Oxweld Railroad Service Company, Chicago; oxy-acetylene welding and cutting apparatus, oxygen, acetylene, carbide; Lem Adams, M. Burnett, Jr., W. E. Donalds, S. P. Donegan, F. J. Duffy, J. R. Garrett, W. H. Kofmehl, D. H. Pittman, L. C. Ryan and J. C. Stephenson.

P & M Company, Chicago; rail anti-creepers and bond-wire protectors, tie plate assemblies; J. J. Gallagher, D. T. Hallberg, P. H. Hamilton, G. E. Johnson, J. E. Mahoney, W. A. Maxwell, F. S. Schwinn, Jr., G. E. Webster and G. T. Willard.

Pocket List of Railroad Officials, New York; copies of Pocket List of Railroad Officials; H. A. Brown and B. J. Wilson.

Positive Rail Anchor Company, Chicago; rail anchors and guard-rail plates and braces, adjustable rail braces; L. C. Ferguson and A. H. Told.

Q & C Company, New York; guard-rail clamp, switch-point guard, electric snow melter, compromise joints, derail, gaging tools, rail tongs and gage rods; G. H. Goodell, L. E. Hassman, J. L. Terry and Lewis Thomas.

Rail Joint Company, New York; insulated and standard rail joints; Alex Chapman, E. A. Condit, W. E. Gadd, Harry C. Hickey, G. H. Larson, R. W. Payne and Thomas Ryan.

Rails Company, New Haven, Conn.; M & L track, compression track construction, compression screw spike, full throated cut spike, oil, gas and electric switch heaters, track lubricator; L. T. Burwell.

Railway Engineering and Maintenance, Chicago; copies of *Railway Engineering and Maintenance* and Railway Age; G. E. Boyd, M. H. Dick, S. W. Hickey, N. D. Howard, Elmer T. Howson, F. C. Koch, W. S. Lacher, J. G. Little, H. E. McCandless and H. A. Morrison.

Railway Purchases & Stores, Chicago; copies of Railway Purchases and Stores; J. P. Murphy and K. F. Sheeran.

Railway Track-Work Company, Philadelphia, Pa.; portable electric track grinder, portable stock-rail grinder, rail-joint cross grinder, portable reciprocating grinder, portable flexible shaft grinder and grinding wheels; W. B. Goodall, H. M. Moorhead and A. M. Nardini.

Ramapo Ajax Corporation, New York; switch stands, rail lubricators, metal highway crossings; W. Bender, W. M. Brooks, G. A. Carlson, G. M. Cooper, R. E. Einstein, H. Hazelton, A. F. Hess, Hilton P. Hoffman, A. F. Huber, J. S. Hutchins, W. Janicki, S. A. McVicker and W. Perdue.

S. E. Rawls Company, Streator, Ill.; railway track and right-of-way mowing equipment; C. F. Butts, E. J. Jaeger, L. C. Meskimen, M. E. Rawls and S. E. Rawls.

Republic Steel Corporation, Cleveland, Ohio; curve guard rail, tie plates, lockers, filing cabinets, steel fence posts, wire, nails, staples, track spikes, corrugated culverts, highway crossings, track bolts and nuts, and steel tubing; C. H. Aiken, A. E. Brown, C. H. Ellison, L. W. Fletcher, A. D. McAdam, C. F. Newpher, W. T. O'Neill, A. J. Roof, C. W. Ruth and L. L. Solger.

Sellers Manufacturing Company, Chicago; wrought iron tie plates and angle bars; J. T. Flynn, G. M. Hogan, R. J. Platt and R. A. Van Houten.

Teleweld, Inc., Chicago; rail joint shims, samples of welded rails showing effects of pre-heating, samples of heat-treated rail and field hardness testing kit; C. R. Fohs and G. A. Green.

Templeton, Kenly & Company, Chicago; track and bridge jacks, tie spacer, and rail puller and expander; R. B. Hill, P. H. McManus, Chas. Neher, Wm. Simpson, J. B. Templeton and W. B. Templeton.

Woodings-Verona Tool Works and Woodings Forge & Tool Company, Verona, Pa.; rail anchors, gaging tool, track levels and gages, spring-clip and bent-shoulder tie plates and lock washers; James McComb, R. J. McComb, G. L. McKewin, J. M. Moore and W. H. Woodings.

Can Tie Spacing Be Made Wider?

When going to a heavy rail section, say above 100-lb., is it practicable to adopt a wider tie spacing? If not, why? If so, how much?

Ties Have Two Functions

By W. H. Sparks
General Inspector of Track, Chesapeake & Ohio, Russell, Ky.

Ties have two functions: (1) to act as a direct support for the rail; and (2) to distribute the traffic load, through the ballast, to the roadbed. The primary purpose of using heavier rail is to provide a stiffer support for the wheel loads and thus, by distributing these loads to a larger number of ties, reduce the maximum load on each tie and, as a corollary, the intensity of the load which each tie transmits to the roadbed.

Despite the heavier and stiffer rail, the larger ties and the wider and longer tie plates which we are now using, we still have plate-cut ties. While less aggravated, plate cutting is only the modern form of rail cutting which formerly destroyed so many ties that would otherwise have lasted much longer. Furthermore, the number of ties in a panel has a direct influence on the tendency of the rail to spread. Other things being equal, the closest practical spacing will give the highest resistance to spreading and thus reduce the amount of gagging, which is also destructive to ties.

Since one of the purposes of heavy rail is to reduce the load which the individual tie must transmit to the roadbed, if the tie spacing is increased, a part of the advantage of the heavier rail is lost immediately. In fact, by increasing the spacing enough it would be possible to lose all of this advantage. The railways are all suffering from soft spots which had their inception in excessive loading of individual ties, although this was sometimes combined with too little ballast.

For these reasons, I am opposed to increasing the tie spacing merely because heavier rail is being laid. On the other hand, the spacing can be so close that it interfers with the tamping of the ties.

Is Opposed to It

By J. Morgan
Supervisor, Central of Georgia, Leeds, Ala.

I am opposed to thinning out the ties simply because the new rail is heavier than that which it replaces. The same wheel loads must be carried by the new rail and by the ties. We now suffer from considerable mechanical destruction under our 90 and 100-lb. rail as the tie plates wear into the ties. Increasing the tie spacing will not improve this condition, since we will have at least as much, and probably more, tie wear with the wider spacing. Therefore, if there are not too many ties under the old rail there will not be too many under the new rail to provide the direct bearing which it should have.

Assuming, however, that the ties will carry the wheel loads satisfactorily if the spacing is widened, there is another element which must be considered. Before deciding to thin out our ties we must know how the subgrade will be affected. If the subgrade is stable and well drained, and there is an ample depth of 1½ to 2-in. stone ballast, it might be practical to increase the spacing somewhat, since this type of ballast, if it has sufficient depth, distributes the load quite uniformly to the roadbed. On the other hand, the finer types of ballast do not distribute the load, but transmit it to the subgrade with scarcely any spreading out. The effect on the sub-

Send your answers to any of the questions to the What's the Answer editor. He will welcome also any questions you wish to have discussed.

To Be Answered in December

1. Is a four-bolt or a six-bolt joint more effective as a rail fastening? Why? If the latter, is its advantage sufficient to justify its additional cost?

2. To what extent is it practicable to use off-track power equipment in the construction and maintenance of bridges?

3. What special equipment and supplies should be supplied to the section forces for fighting snow? What disposition should be made of them when winter ends?

4. To what extent is it practical to equip small and medium size stations with weather strips and storm windows?

5. What are the relative advantages and disadvantages of building up frogs by welding in the track and of sending them to a shop to be reconditioned? What additional life can be expected from a built-up frog?

6. What considerations should govern the location of fire hydrants around engine-house and shops? What other forms of fire protection should be provided?

7. What is the significance of the several branding marks on rail? What importance should be attached to each?

8. When inspecting masonry substructures, what items should be given particular attention? What is the importance of each?

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Must Have Support

By L. A. Rape
Extra Foreman, Baltimore & Ohio, Wampum, Pa.

The usual reason for using a heavier section of rail is that tonnage and speed have increased to the point where the old rail has become inadequate to carry the traffic or cannot do so economically—that is, too much maintenance is required. Basically, this is because the old rail is not receiving enough support, which can be provided only by the ties and roadbed.

There is a practical limit to the closeness with which ties can be spaced, since there must be sufficient room between them to permit tamping. If close spacing, observing this limit, gave enough support to the old rail to enable it to carry the traffic, the heavier rail would have been unnecessary.

Since the heavy section will be stiffer than the lighter rail, it will distribute the wheel loads to more ties. For this reason, if the tie spacing under the old rail has been crowded in an effort to give it better support, the spacing under the new rail should be increased to at least 20 and preferably 21 in., center to center of ties. This spacing should give the support which the rail must have and will provide sufficient room for tamping. This discussion presupposes ample depth of ballast.

They Distribute the Load

By C. W. Baldridge
Assistant Engineer, Atchison, Topeka & Santa Fe, Chicago

Crossties are the foundation members which transmit and distribute the load imposed upon the track to the underlying support—the roadbed. The object of using a heavier rail section is to provide for a greater distribution of the load, which can be accomplished only by spreading it onto more ties. Larger, stronger and stiffer rails will accomplish this, provided there are more ties within the effective distance to which the rails are able to spread the load. If the spacing remains the same, the load will be transmitted to more ties. If, on the other hand, the spacing is increased, say to the point where the number of ties within this effective distance of spread is the same as it was within the effective load-distributing distance of the lighter rail, the only change effected is a small decrease in the cost of the ties. As against this there will be a large increase in the cost of the rail, the final result being a net loss.

Depends on Class of Track

By W. O. Frame
Assistant Superintendent, Chicago, Burlington & Quincy, Wymore, Neb.

Whether the tie spacing should be widened when a heavier rail section is laid will be determined largely by the importance of the line involved. Almost without exception, the reasons for increasing the weight of rail on principal main lines arises from the fact that the weight of locomotives and cars, and the speed of trains, have increased to the point where a heavier section becomes desirable and, in some cases, even necessary. Where the heavier rail has been laid for these reasons, there can be no justification for going to a wider tie spacing, since an adequate timber support is a factor that cannot be ignored with impunity.

When renewing rail on a branch line it is customary to use second-hand rail released from a line of much heavier traffic. The section to be used is usually much heavier than that which is to be replaced; in many cases it is heavier than can be justified by the tonnage passing over the branch or the class of traffic it will carry. The primary reasons for its use under these conditions are that it is readily available, and that there is usually no other satisfactory outlet for the rail.

While the question refers to sections heavier than 100-lb., the changes I have in mind are the replacement of sections ranging from 56 to 70 lb. with released rail weighing from 85 to 100 lb. Where the rail on a branch line is stepped up in this way, for reasons of economy a wider tie spacing can be used without detriment to the track structure. I have found it practicable to increase the spacing, that is, the distance between the tie faces, or the center to center distance, from one to five inches. The saving effected by reducing the ties by 130 to 530 per mile, amounts to from $18 to $74 a mile a year.

Removing Paint from Plaster

What is the best method of removing paint from plaster?

May Be Difficult

By Superintendent of Buildings

In the past this has been one of the most difficult jobs confronting a painter. For this reason, when a job of decorating is being done, there has been a tendency merely to wash the surface and add another coat of paint. Obviously, however, there is a limit to the number of times this can be done and still retain a satisfactory surface, so that removal of the paint becomes necessary eventually. If the paint begins to peel, as it may under certain conditions, particularly if the material used for the original coat was not of the best quality, it will also be necessary to remove all of the paint from the wall in order to insure a smooth surface.

It is seldom possible to use a scraper for this purpose, because even with the greatest care one cannot avoid gouging the plaster, for even where peeling is most aggravated certain areas will continue to adhere to the plaster with astonishing persistence. A torch is no more satisfactory, since the flame seems to have little effect on wall paint and usually the operator succeeds only in scorching the woodwork. I remember a case where a superintendent insisted that the paint be removed from the walls of his office before it was repainted. The foreman made an honest effort to do so, but damaged the wall so badly that the room had to be replastered.

At that time, while paint removers were available, they were not effective on wall paint. At present, however, slow-drying paint removers are on the market, which can be used with marked success for removing paint from plaster walls. These recently-developed removers must generally be applied liberally but uniformly over the painted surface and allowed to remain for at least an hour, and in some cases longer. They do not dissolve but only soften the

paint, which can be pulled off in strips, leaving a clean wall surface. After the paint is off, the wall must be washed and allowed to dry before it is repainted in order to assure complete adherence of the new paint.

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Again, for the same reason, the ordinary run of paint removers are as useless as the blow torch. Recently, however, a new type of slow-drying paint remover has come onto the market, which is very effective in removing wall paint. In use, the remover is spread over the painted surface and allowed to remain for a sufficient time, say an hour or more, depending on the particular brand, until the paint is well softened. The scraper can then be used carefully, to avoid gouging the plaster, to strip off the old paint. After a little practice one can peel the paint off, leaving the wall surface clean. After all of the paint is off, the wall should be washed before it is repainted. Directions covering the entire operation are printed on the package containing the remover.

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Such borings insure better penetration of the preservative under the rail seat, especially since our standard crossties are of upland red oak. They also practically eliminate field boring which exposes untreated wood below the zone of penetration of the preservative. The elimination of this field-labor item releases time for other duties.

Disadvantages arise when occasional incorrect boring of the ties or punching of the plates necessitates the filling of the holes with plugs and the reboring of the holes in the field. For this reason, frequent checking of the boring at the treating plant and adequate inspection of the tie plates at the mill must be maintained. If slight inaccuracies in both cases are cumulative, the gross error may be sufficient to cause trouble. On the other hand, if the individual errors are compensating little difficulty will be experienced in application.

Accurate templates are provided at the tie-boring mill as guides for the bits and, in addition, tie inspectors are provided with xylonite templates of the same dimensions as the largest tie plates, with all borings made accurately. Since these templates are transparent, it is a comparatively simple matter to superimpose them upon the bored ties and thus obtain immediately an accurate check.

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My entire experience with tie-plate lag screws has been in connection with ties that have been bored in the field. Based on this experience, I believe that it is best to bore the ties after they have been installed in the track, the reason being that there is a possibility that after the ties have passed through the treating plant and are delivered, some of them may not be used for a considerable time, during which period the timber may shrink enough to make the borings inaccurate.

After the tie plates have been installed and the tie plates have been in place a sufficient time to settle thoroughly, any inaccuracy in the gage can be corrected. The ties can then be bored and the lag screws, or cut spikes as the case may be, can be applied with the assurance of a complete fit. Equipment for field boring is available, which will do the work efficiently and economically.

Assures Longer Life

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It is no longer a matter of debate that the preboring of any material that is to be given preservative treatment tends to increase its life, as compared with field boring after treatment, and ties afford no exception to this rule. In fact, crossties offer more convincing evidence of the advantages of preboring than most timbers, for few others are subject to so much abuse as ties at the point where the preboring is done by both the mechanical action of the tie plates and destruction of the wood by spiking.

When the preboring of bridge timbers was first advocated, there was much opposition to the proposal on the ground that the difficulty of matching in the field, holes that were bored at the treating plant, perhaps before the piles were driven, would be insurmountable. Yet today we are doing the thing that was so loudly proclaimed couldn't be done, and are doing it with an error of only a fraction of one per cent.

Now the same arguments are being advanced, modified, of course, to fit the theme that the laying of rail must be done under so much pressure that time is not available to insure the accuracy of fit that is made essential by preboring. Yet at the same time, there is any amount of discussion of the refinements that have been introduced into track work to provide comfortable riding on trains that are being operated at the higher speeds that are becoming so popular.

It has been my observation that the preboring of holes for tie-plate lag screws saves considerable time in the field, although one encounters some inaccuracies, in addition to that required to apply the independent fastenings. Certainly the time and labor required for the hand boring are eliminated, and this is no small item. Aside from this consideration, the potential increase in the life of the tie cannot be ignored.

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eter and partly through failure to get all of the holes deep enough. The diameter of the hole should not be more than ⅛ in. less than that of the lag screw, and the prebored hole should go completely through the tie. As a rule, prebored holes are accurate, and this feature should be susceptible of control through efficient inspection at the boring plant.

Weighs Both Sides

By G. M. Cornell
Transportation Inspector, Chesapeake & Ohio, Richmond, Va.

At least four arguments have been presented in favor of preboring ties for lag screws: (1) the prebored hole permits thorough penetration of the preservative around the location of the screw, thus tending to increase the effective life of the screwed fastening and the overall life of the tie, while exceptionally good penetration is assured under the tie plate where the tie receives most of its abuse; (2) the prebored hole extends through the tie, thus assuring drainage of the lag-screw fastening, which also tends to extend the life of the fastening and of the tie; (3) a perpendicular hole is produced; and (4) where the lag screws are driven into the prebored holes the track is certain to be to gage.

The advantages of vertical holes for the lag screws are obvious. There is more or less variation in the direction of holes made in the field with freehand drills, depending on the skill of the operator. If a spring washer is used with the lag screw, a slight divergence will make little difference, but where the spring washer is not used any divergence will reduce the bearing contact between the screw and the plate.

Probably the main disadvantages of preboring result from failure of the track forces to aline the holes in the tie plates with the holes in the tie. Assuming that the boring has been done correctly, there are several reasons why they may not line up with the tie plates. If considerable care is not exercised to insure that the adzed surfaces of the old ties are truly horizontal (on tangent) the rail will be tilted and when spiked to gage, the base and hence the tie plate will not be in their calculated positions, so that the holes will not match. Again, the ties may be slued somewhat. If one end of the tie is slued 4 in., the tie-plate holes will lack ¼ in. of matching the prebored holes. Finally, if the rail has not been gaged properly, the holes in the tie plate and tie cannot be expected to match.

When these holes do not match, the results are wholly undesirable. First, the holes in the tie must be reamed to center them with those in the tie plate. When doing this the bit can be controlled only with extreme difficulty, with the likelihood that it will be broken. Again, a poorly matched hole almost invariably results in a slanting or improperly placed hole unless the tie plate is offset enough to make an entirely new hole necessary. The bit tends to run into the existing hole, and thus out of perpendicular, while it also moves horizontally. A screw put in such a hole will usually have the edges of the thread cut off by the tie plate as it goes down. Finally, an off-center hole that is reamed is often oval in shape, thus reducing the holding power of the lag screw.

A further disadvantage of the prebored hole is that it fills with sand, gravel and dirt, which mix with the exuding preservative to form a conglomerate, making the hole difficult to ream and requiring excessive sharpening of the bits. If all of the holes are properly centered, however, this objection becomes of little or no consequence.

Consideration of the foregoing advantages and disadvantages of preboring ties for lag screws leads to the conclusion that the disadvantages of the practice arise principally from lack of refinement in placing the rails. The centering of the tie-plate hole with the prebored hole requires an exactitude which, while desirable, is seldom attained in present-day rail-laying practice. If a system were in effect whereby the plates were fastened to the ties at the treating plant, changes in the methods of laying rails and installing ties would be necessary, which would assure complete alinement, both vertically and horizontally, of the rail, the tie plate and the tie.

Until some such system is put into effect, steps should be taken to eliminate these disadvantages by stopping the preboring for lag screws. While this will eliminate the protection afforded by the preservative which is injected around the hole, this can be offset to some extent by the injection of preservative by the screw in driving.

If the hole is bored only part way through the tie and is then filled for two or three inches with preservative, it will be forced into the wood fibre by the pressure of the screw as it is turned down into place. Tests show that by this means the preservative can be forced into the wood ¼ in. around the hole.

A second suggestion is that the holes be prebored but plugged after treatment, thereby insuring that the hand-bored holes will be driven through impregnated wood. This will afford the desired protection against decay and at the same time insure that the holes will be where they will function properly.

Supporting Weak Girder Spans

When it becomes necessary to support a weak girder span on falsework, what precautions should be observed? Why?

Depends on Many Factors

By F. H. Cramer
Assistant Bridge Engineer, Chicago, Burlington & Quincy, Chicago

Before deciding on the support for a weak girder span, one should study carefully all of the conditions surrounding the structure It is my experience that the most important factor affecting the final plan will be the class of loading which the span must carry. Next in order for consideration, the character of the stream will determine whether the falsework shall be placed at the center or quarter points of the span. After this point has been settled, the height from the bed of the stream to the low part of the steel must be considered in connection with the decision whether single or double bents shall be driven.

Having determined the position of the bents, investigation should be made of the steel span. If a bent of falsework is placed at the center of the span, the depth of the girders, the spacing of the flange rivets, the web splices and the web should be studied and the respective stresses calculated. In many cases stiffeners will be required to care for the reaction loads which will be developed.

Care must also be exercised to avoid getting the bent or bents too high or wedges driven too tightly under the steel, as this may cause rocking and create cantilever stresses in the top flanges of the girders. In time also, this condition may arise if the end-bearing materials crush somewhat under heavier loading. After the falsework is in service, fre-

quent observation should be made to see that the timber members are in proper position, particularly as to height, and whether noticeable settlement of the piling has occurred.

Bents Must Be Solid

By L. G. Byrd
Supervisor of Bridges and Buildings, Missouri Pacific, Poplar Bluff, Mo.

When falsework is placed to support a weak girder span, it is essential that the bents provide a firm solid support, with equal bearing under each girder. They should have a clearance of approximately 2 in. from the top of the cap to the bottom of the girder, to allow the bearing to be taken up by oak wedges driven from both sides. If double bents are considered necessary, they should be placed as close together as practicable, with nosing timbers upstream to prevent drift from lodging against them.

Where possible, the bearing over the bents should be so located as to bring them under stiffeners. In many cases, it is necessary to add stiffeners made of heavy angles or heavy bridge timbers. The latter should be wedged to a tight fit and uniform bearing between the upper and lower flanges of the girders, to eliminate any chance of the girder buckling or of the flanges bending. The stiffeners should be secured in place by firmly bolting them to the girders.

Which Rail to Surface First

When surfacing track, should the high or low rail on a curve first be brought to surface? Why?

First Find What Is Wrong

By W. L. Kelly
General Roadmaster, Erie, New York

Before one starts to surface a curve he must first determine what is wrong with the track. This can usually be determined by checking with a level board. If it is found that there is too much elevation as a result of settlement of the low rail, it is advisable to work along the high rail, surfacing up the low spots and then restore the correct elevation by raising the low rail, always using the level board.

However, if the investigation shows that a general raise is required to correct the conditions which are found, the low rail should first be brought to surface with the spot board and the proper elevation put in the high rail with the level board, but carrying the surfacing of both rails forward together as the work progresses.

Watch the Low Spots

By Jesus Alarcon
Trackman, Atchison, Topeka & Santa Fe, Hinkley, Cal.

In common practice the inner or low rail of a curve is the grade rail. For this reason, when spot surfacing it is usually better to surface this rail and then bring the outer rail to the correct relative elevation through the use of the level board. It is important, however, that every joint be tested with the level in advance of the surfacing to determine the uniformity or lack of uniformity of the superelevation, using particular care in doing this on easement curves. On a curve that has not been surfaced for some time there may be too much elevation owing to settlement of the low rail. In this event it may be desirable first to surface the high rail and then bring the low rail to its correct relative position by means of the level board.

Surfaces Low Rails First

By Henry Becker
Section Foreman, St. Louis-San Francisco, Rush Tower, Mo.

It has been my practice, when doing a complete job of surfacing a curve, without making a general raise, to bring the low rail to a smooth surface and then, using the track level, bring the high rail to the correct elevation. This will insure the best riding condition, for it is practically impossible to obtain the proper run off at either end of the curve by eye, which will obviously be necessary if the high rail is raised first. On the other hand, if grade stakes have been set this difficulty will not arise, since the high rail can be raised to the stakes and the low rail then brought up.

If one is merely leveling around a curve, it is practicable to pick up the low spots on the high rail and then raise the low rail with the level board. In the third case, in which a substantial raise is being made, say up to 2 in., the conditions are quite similar to those first mentioned. In this case, the difficulty of obtaining a smooth-riding run off is almost insurmountable unless the low rail is considered the grade rail and the elevation of the high rail is established with the level board.

Always Use Track Level

By A. W. Appelquist
Roadmaster, Minneapolis, St. Paul & Sault St. Marie, Bismark, N. D.

When grade stakes are set for surfacing, grade is usually established on the low or inside rail of a curve. In this case the low rail will be raised first with the spot board and the elevation of the high rail will be given with the track level. In surfacing a curve on old ballast, however, it is generally found that there is too much elevation due to settlement of the low rail. In this case the high rail should first be brought to a smooth surface and the low rail brought to the correct relative elevation by using the level board.

As the foreman sights the high rail of the curve he should have his level board with him and take levels at every joint to make sure that he does not run into a high spot in the inside rail, as this will cause the track to be without uniform elevation. For this reason, before surfacing, it is always well to check the entire curve with respect to elevation, sags and weak shoulder. It is really better to truck in additional material before making a lift, because it happens so many times that when one wants to close in a hurry for a train he finds that he has just reached a spot where the lift is high and the material scarce. Where a compound curve is to be surfaced, the foreman should mark the elevation on the rail in advance, as this will save time and avoid the possibility of running by the point of compound curve with the wrong elevation.

Two Ways to Do It

By Robert White
Extra Foreman, Grand Trunk Western, Pontiac, Mich.

Where the curve is being lifted with the spot board, I prefer to bring both rails up at the same time. However, the jack under the low rail should not come up faster than the jack under the high rail. In fact, I find it desirable to keep the jack on the low side two or more notches behind the one on the high side, until

the latter rail is to surface, after which the raising of the low side is completed. Both rails should then be tamped at the jacks at the same time.

If the surfacing gang is small, say when made up of the forces from several sections, it is best to surface one rail at a time to avoid delaying traffic. In this case, especially in out-of-face surfacing, the low rail should be surfaced first. It is my experience that the high rail is the one that stands most in need of surfacing. Yet there are many cases where a number of rails on the low side will not need to be raised, for which reason, if the bad spots are picked up, it will not be necessary to surface this rail throughout the length of the curve. In this case, when the low rail has been completed, the level will readily indicate the points where the high side needs attention.

It is obvious that when the high rail has been lifted, the low rail will also need to be raised, in which event it should be tamped inside of the rail. Where only a little elevation is required, as on light curves, it may be necessary to tamp the ties outside of the low rail, although in general I do not approve of tamping the ends of the ties outside of the low rail. I have observed that the best results are usually obtained if the ties are well tamped under the low rail and for only a shovel width outside.

How to Make Whitewash

How should whitewash be made to get best results?

There Are Many Formulas

By Foreman Painter

There are a multitude of formulas for preparing whitewash, several of which are satisfactory and about equally effective, others of which give excellent results for a while, after which the whitewash begins to peel or wash off, and some of which are not at all satisfactory, since they fail after only a short exposure. Because so many mixtures fail, every man who has succeeded in finding one that gives good results, believes that his is the best and will go to some trouble to maintain his position.

For this reason, it is difficult to say that one of these formulas is superior to all others. The mixture which I have found to be most satisfactory for use on wing fences, cattle guards and other outdoor use is made as follows: To ½ bu. of well slaked lime add 1 peck of salt dissolved in hot water. At the same time dissolve 3 lb. of rice flour in hot water and boil, adding sufficient water during the process to produce a thin paste. Also dissolve ½ lb. of whiting in warm water and add it to the rice paste. Dissolve 1 lb. of glue, of the type used by joiners, in hot water. Add it to the rice and whiting mixture while still hot and see that these three ingredients are thoroughly mixed, keeping them hot and the mixture thin. Then while both of the basic mixtures are still hot add the rice-whiting-glue mixture to the lime-salt mixture and stir until thoroughly incorporated. While this mixture can be applied cold, the mixture is generally so stiff that the film is too thick and the results are not satisfactory. If the whole mixture is applied hot, however, it will be thin enough to obtain a good coverage without danger of peeling and the application will remain satisfactory for months.

Section Forces Apply

By Supervisor of Track

I have always required my section gangs to mix and apply whitewash, the mixture being made in accordance with a formula which was given me some years ago by a painter who had been quite successful in preparing whitewash that lasted well and did not turn yellow. I have found from experience, however, that certain precautions are necessary if good results are to be expected.

In the first place, it is important that the lime be of good quality, well burned and without indication of air slaking. Even a small amount of air-slaked lime will ruin the mixture. It should be slaked with boiling water, and the vessel in which it is slaked should be kept well covered with gunny sacks during the process. After slaking, it should be thinned enough to allow it to be strained to remove any unslaked particles. For any given quantity of unslaked lime, take one-half the volume of salt and dissolve it in boiling water, using only enough water to dissolve the salt completely, and pour the solution into the strained lime while both are still hot, using care to mix them thoroughly.

In the meantime, the necessary quantity of beef suet should be rendered and poured into the lime and salt mixture while all of the ingredients are still hot. As before, the mixing should be done carefully and thoroughly, while in this case it is well to do it quickly. The relative proportions of the three ingredients are 1 bu. of unslaked lime, ½ bu. of coarse refined salt and 15 lb. of hot fat from the suet.

This mixture cannot be applied cold, but can be applied easily with either a brush or a spraying machine after it has been heated enough to give it a thin consistency. This mixture adheres well and does not lose body or turn yellow after exposure to the elements.

Purpose of Check Valves

What is the purpose of a check valve in a discharge line? In a suction line? Where should it be located?

Should Be Near the Pump

By W. L. Curtis
Mechanical Engineer, New York Central, New York

A check valve in a discharge line should be placed as near the pump as practicable, this being especially desirable when pumping against a considerable head for it will relieve the pump when starting and thus make starting easier. A check valve should always be installed in connection with pumps of the centrifugal type. In this location, a check valve will hold the water back and render it unnecessary to drain the discharge line when it becomes necessary to inspect or repair the water end of the pump.

Frequently, for economical reasons, suction lines are constructed of light-weight pipe. If such a pipe is fitted with a foot valve, and the pump valves leak even a very little, the heavy static pressure which may be developed, if the discharge head is of considerable magnitude, when the pump is idle, may cause a failure in the suction line. A check valve in the discharge line will prevent this.

A foot valve, which is only a special form of check valve, should always be placed at the lower end of the suc-

tion pipe line. This is especially desirable where the suction lift is high and is essential with centrifugal pumps. The foot valve prevents the suction line from emptying while the pump is at rest, and the water from slipping back while the pump is running. For these reasons it insures prompt starting and smooth operation of the equipment.

Help in Priming

By J. P. Hanley
Water Service Inspector, Illinois Central, Chicago

Check valves are installed on suction lines served by reciprocating pumps primarily to prevent a return flow of water into the pump between pulsations or when the pump is not in operation. This arrangement affords dependable protection in these respects, while it is much more convenient than closing a gate valve when the pump is shut down. A check valve in the discharge line also relieves the valve plates and springs in the pump from suffering unnecessary interference and insures smoother pump operation.

Pump-priming lines are connected on the pressure side of check valves, which permits the primers to function and the pump to vent the air from the suction without undue back pressure or water waste. Check valves are essential for priming centrifugal pumps.

The use of check valves at different levels, or what is known as step check valves, is necessary in discharge lines supplying roof tanks on tall buildings and in lines in the mountains. This permits the back pressure to be taken care of on the relay principle, instead of controlling the total altitude pressure, with the probability of excessive water hammer, by means of a single check valve at the bottom of the line.

Check valves in suction lines answer the same purpose as foot valves, except that foot valves are located at the ends of suction lines near the lower end of the pipes, while a check valve may be installed on the bottom end of the pipe or at a point on the water's edge approximately at high-water elevation. I have used them in the latter position in streams subject to flood with ice and debris, where foot-valves could not be reached for cleaning during high water. Under these conditions a foot valve might leak enough to prevent priming the pumps. In these cases, check valves generally give better results than foot valves.

Checking Up On Scour

What is the most practical way to take soundings around trestle bents and masonry piers to determine whether scour is taking place?

Resorts to Many Devices

By H. Austil
Bridge Engineer, Mobile & Ohio, St. Louis, Mo.

I cannot say what is *the* most practical way of taking soundings to determine whether scour is occuring. I have used a brickbat on the end of a string, a metal sinker on the end of a tape line, a regular sounding lead, a steel rod, a pipe, and I have taken borings. In other words, I have used the means available and taken the action which the situation seemed to require. On some occasions I have even climbed overboard and made my own underwater investigation.

However, the important thing is to know what the original depth was and that the soundings are correct and represent the true condition around the foundation or bent. In many cases drift accumulates against a trestle or pier during freshets and may cause considerable scour. Then a few hours after the water begins to fall or the current approaches normal velocity, the hole thus scoured will fill with sand or silt. In such cases, the important thing is to know what the depth was before this filling began. To determine this it is best to take a boring, unless accurate soundings were taken during the freshet.

Obviously, if the current is swift, it is impossible, or at best difficult, to get accurate results with a sounding line of any kind. But in quiet water any of the makeshifts which have been mentioned will do the job and answer the purpose, provided one is certain that the bottom is hard and is not covered with material which will move downstream at the first increase in current velocity. I have known places where the elevation of the bottom varied several feet every day due to shifting sand moving with the tide. A record should be kept of the length of every pile driven in a trestle, so that when scour does occur, it can always be determined what the actual penetration is.

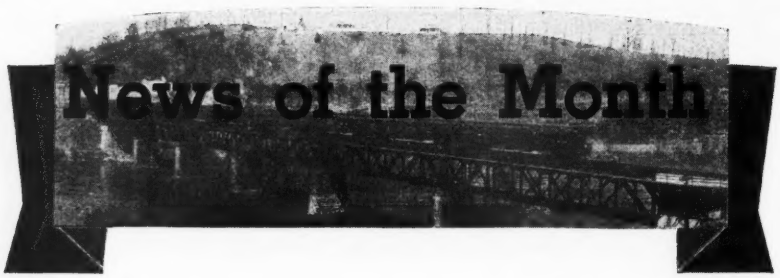
Must Have Accurate Record

By L. G. Byrd
Supervisor of Bridges and Buildings, Missouri Pacific, Poplar Bluff, Mo.

If one is to gain an intelligent idea of what is occurring around structures during freshets, it becomes necessary that he have a complete record of the penetration of every pile in trestle bents and in the foundation of masonry substructures. While the question refers only to piers, there are many cases where abutments and wing walls suffer from undermining as much as piers during flood stages. The record of the structure should also include accurate measurement of the distance from the base of rail to the normal ground line or stream bed on each side of every bent and pier and in front of both abutments. If the structure contains one or more long spans the profile of the ground line or stream bed between the span supports should be plotted accurately. Without this information there is no way of telling how much scour has occurred.

If the velocity of the current is not great, a sounding lead, attached to a line which is marked in feet, can be used to advantage. The line, however, should be of the smallest diameter that will safely hold the weight; a good strong fish line will often do the job. Where the velocity of the water is high, a sounding line is usually worse than useless as it is seldom possible to manipulate it, even when a heavy weight is used, and where it can be handled the measurements are rarely dependable. In rapidly flowing water a steel rod 1½ in. in diameter will usually give the best results. In using it, it should be pointed slightly up stream and allowed to drop quickly, catching the mark at which the rod is brought up on the bottom. It should be recognized that soundings taken during flood stages are likely to vary somewhat from the actual depth and that the conditions as found may change for the better or for worse within a few minutes, particularly if the bottom is easily eroded.

It has been my experience that it is usually difficult and sometimes impossible to obtain accurate scouring data, particularly around masonry substructures, without using a boat. It is important also that the boat be moored to some secure object in such a way that it will be held in place while the soundings are being made.



Denver Zephyrs Travel 200,000 Miles in 97 Days

The Advance Denver Zephyrs of the Chicago, Burlington & Quincy, which were placed in service on a 16-hour schedule between Chicago and Denver, Colo., on May 31, completed 200,000 miles on September 5. On these 194 trips, these trains were late only four times. The schedule calls for an average of 65 miles an hour. A total of 14,669 passengers was carried on the 194 trips.

Largest Raisin Shipment

The largest single shipment in the history of California's raisin industry left the main plant of the Sun-Maid Raisin Growers' Association at Fresno, Cal., recently en route to Kansas City, Mo. It consisted of approximately 2,000 tons of raisins in bulk and package, valued at more than $200,000, and was carried in a train of 60 cars. The train moved over the Atchison, Topeka & Santa Fe on a perishable freight schedule.

August Employment Shows Further Increase

The Class I railways had 1,090,016 employees on their payrolls as of the middle of August, an increase of 78,986 employees, or 7.81 per cent, as compared with August, 1935, according to figures compiled by the Interstate Commerce Commission. Employment in August, 1936, showed an increase of 5,190, or 0.48 per cent, as compared with the previous month. With adjustments for seasonal variations, the Bureau of Statistics of the Interstate Commerce Commisison estimates that railroad employment in August was 59.5 per cent of the average of the 1923-25 period.

Rail Market Activity

Following the usual summer lull the rail market is giving promise of reaching a high degree of activity during the ensuing months. What promises to be one of the largest rail buying programs of the season is that of the Atchison, Topeka & Santa Fe, which road is inquiring for 90,000 tons of rails for its 1937 rail laying program. In addition, during the last month the Chicago Great Western has ordered 10,000 tons of rails, placing 8,000 tons with the Carnegie-Illinois Steel Corporation and 2,000 tons with the Inland Steel Company, and the Seaboard Air Line has ordered 10,000 tons of 100-lb. rail—6,800 tons from the Tennessee Coal, Iron & Railroad Company and 3,200 tons from the Bethlehem Steel Company. The Wabash has been authorized by the Federal District court to purchase 5,000 tons of rails, together with the necessary accessories, at an aggregate cost of $269,023.

Labor Day Traffic Best Since 1929

Railroads throughout the country reported that during the Labor Day holiday the volume of passenger traffic handled was the largest since 1929 and exceeded the volume of traffic carried at the same time last year by a wide margin. In the East the increases over last year ranged up to 100 per cent while on the Western roads the composite increase was estimated at 35 per cent. Practically all roads found it necessary to operate extra trains and to add cars to regular trains. One railroad in the West reported that the business handled this year was the largest holiday business ever experienced, necessitating the employment of every available passenger car, including suburban cars, to carry inter-city passengers.

Ruling Protects Pensions of Employees Over 65

The Railroad Retirement Board has announced a plan of procedure by which railroad employees who have reached the age of 65 years may remain in service without reduction in the amount of the retirement annuity payable to them on retirement under the terms of the Railroad Retirement act. The law provides for a reduction of one-fifteenth in the retirement auunity for each year the employee remains in service after he reaches the age of 65, except where employees are continued in employment "under an agreement in writing between the carrier and employee filed with the board, which agreement may provide for extension of employment for one year and thereafter in like manner for successive periods of one year each." Because the railroads have obtained an injunction restraining the collection of taxes from them for the purpose of paying pensions, most of them have declined to sign such agreements. In order to remedy this situation, the board has announced that a general statement by the carrier to employees over 65 that they may continue in service and a letter by the employees to the carrier agreeing to continue, the board said, will, if filed with the board, be sufficient to constitute compliance with the act under regulations adopted on September 10. Another regulation provides that an employee who is in fact continued in service complies with the act and avoids reduction in annuity if he signs an agreement to continue in service on the form prescribed by the board and submits with it an affidavit stating that he attempted to secure the signature of the proper carrier officer and such signature was refused, and that he has given notice to the carrier of his wish to remain in service by delivering a copy of the continued service agreement to a carrier officer personally or mailing it to the carrier.

Federal Grade Crossing Program Nearing Completion

That rapid progress is being made in carrying out the grade crossing elimination program for which provision was made in the Emergency Relief Appropriation Act of 1935, is evidenced by figures compiled by the United States Bureau of Public Roads. The Emergency Relief Appropriation Act of 1935 set aside $200,000,000 for grade crossing elimination and protection. As of August 31, according to the Bureau of Public Roads, 250 grade crossings had been eliminated through the separation of grades or the relocation of highways, 12 grade crossings had been given signal protection, and 34 existing structures separating railway-highway grades had been reconstructed to meet modern requirements, at a total cost of $11,407,438. At the same time, elimination or relocation work was under way at 1,093 other crossings, 153 existing structures were being rebuilt, and signal installations were being made at 33 crossings, at a combined estimated cost of $110,161,184. In addition, plans had been approved for the elimination of 305 additional grade crossings through separation or relocation, for the reconstruction or replacing of structures at 45 crossings, and for the installation of signal protection at 581 crossings, at a total estimated cost of $30,366,939. By August 31, there remained a balance of only $47,387,662 of the federal money available for new work.

A.A.R. Expands Public Relations Staff

The Association of American Railroads has expanded its public relations staff with the objective of enlisting the cooperation of the railroads in an extensive long-range campaign to create a new public interest in the railroads, looking to a better understanding and appreciation of accomplishments in the railroad field by demonstrating that the railroads are doing a much better job than most people realize. The association's public relations staff is headed by Robert S. Henry, assistant to the president. Holcombe Parkes, manager of the advertising department of the Norfolk & Western, has been appointed associate director of public relations. William E. Hall, who has been publicity representative of the association, has been appointed manager of the Information section. H. F. McLaury, advertising manager of the Chicago, Burlington & Quincy, has been appointed manager of the Advertising section. B. E. Young, chief clerk of the magazine and advertising departments of

the Norfolk & Western, has been appointed manager of the Railroad section, and an appointment is still to be made of a manager of the Public section. This staff is to work in close co-operation with the Committee on Public Relations of the Eastern Railroads and the Western Railways' Committee on Public Relations, as well as with the public relations officers of the several railroads, the American Railway Magazine Editors' Association, the American Association of Railway Advertising Agents, and the American Railway Development Association.

Railroad Net for July Increases 129 Per Cent

For July the Class I railroads of the United States had a net railway operating income of $61,773,765, which was at the annual rate of return of 2.69 per cent on their property investment, as compared with a net of $26,919,343, or 1.17 per cent, for July, 1935, an increase of 129.5 per cent, according to reports filed by the carriers with the Bureau of Railway Economics of the Association of American Railroads. Operating revenues for July amounted to $349,743,963, as compared with $275,307,553 in July, 1935, an increase of 27 per cent. Operating expenses totaled $248,365,852, as compared with $218,022,449 in the same month in 1935, an increase of 13.9 per cent.

Tour Business in West Near Record

Western tour business during the past season reached the 1929 peak, according to preliminary reports. In many instances escorted tours through the West equalled and in some cases surpassed the record for 1929, which for the national parks and other western outdoor vacation lands was the banner year. The Chicago & North Western now reports the biggest tour year in the history of that line, the total exceeding by several hundred passengers the 1929 high mark on the road. The Chicago, Burlington & Quincy reported a 50 per cent increase over last year's escorted tour figures, and anticipates that final figures will place this year's volume above that of the previous high mark established in 1929. The Chicago, Milwaukee, St. Paul & Pacific reports an increase of approximately 40 per cent in its tour business over last year's mark, with the bulk of tour travel directed to Yellowstone National park and to the Canadian Rockies. The Atchison, Topeka & Santa Fe's tour business during the season just closed was the largest ever experienced on that road.

Union Pacific Bridge over the Missouri River at Omaha, Neb.

Association News

Bridge and Building Association

Practically all of the reports of committees are now in the hands of the secretary, assuring a successful convention at the Hotel Stevens, Chicago, on October 20-22. The program for this convention was published in the September issue of *Railway Engineering and Maintenance*.

Maintenance of Way Club of Chicago

The first meeting for the season of 1936-37 will be held at the Auditorium Hotel on Monday evening, October 26, when Samuel O. Dunn, chairman of the board of the Simmons-Boardman Publishing Company and editor of the Railway Age, will be the speaker.

Roadmasters Association

At a meeting of the executive committee following the adjournment of the convention on September 17, C. A. Lichty, C. & N. W., Chicago, was reappointed assistant secretary in charge of membership and proceedings for the ensuing year. President Haley was authorized to send a letter to the members of the association asking for volunteers for committee work, preliminary to the appointment of committees at a meeting of the executive committee which is to be held sometime in December.

American Railway Engineering Association

Copies of the 1936 Proceedings were mailed to members during the first week of September. The July bulletin, containing a monograph on Railway Car Ferries, American and Foreign, by E. E. R. Tratman, and the status of State Regulation of Motor Vehicles—Passenger and Property Carriers, including laws enacted to November 15, 1935, is expected to be ready for mailing to the members about October 1.

This year the secretary is arranging for a more systematic completion of committee reports. Under this plan the committees are being arranged in six groups with specific dates for forwarding their reports to the secretary's office, as follows: Group 1, 4 committees, September 15; Group 2, 5 committees, October 1; Group 3, 5 committees, November 1; Group 4, 5 committees, December 1; Group 5, 6 committees, January 1; Group 6, 6 committees, February 1.

The manuscript for the revised Manual is now in the printer's hands and more than one-half of it is in type. The present schedule contemplates that the completed Manual will be ready for distribution some time in December.

Nine committees held meetings in September, four of them being scheduled to coincide with the annual convention of the Roadmasters' and Maintenance of Way Association at Chicago, these being as follows: Maintenance of Way Work Equipment, September 15 and 16; Rail, September 16; Track, September 16; and Economics of Railway Labor, September 17. Other meetings during the month were, Buildings, at New York, on September 10 and 11; Water Service, Fire Protection and Sanitation, at Chicago, on September 15; Economics of Bridges and Trestles, at Chicago, on September 18; Wooden bridges and Trestles, at Chicago, on September 25; and Standardization, at New York, on September 28.

Six committees have already scheduled meetings for October, these being Economics of Railway Operation, at Cleveland, Ohio, on October 2; Masonry, at Chicago, on October 8 and 9; Ballast, at New York, on October 16; Ties, at Chicago, on October 21; Wood Preservation, at Chicago, on October 22; and Water Service, Fire Protection and Sanitation, at Chicago, on October 27.

Bridge and Building Supply Men's Association

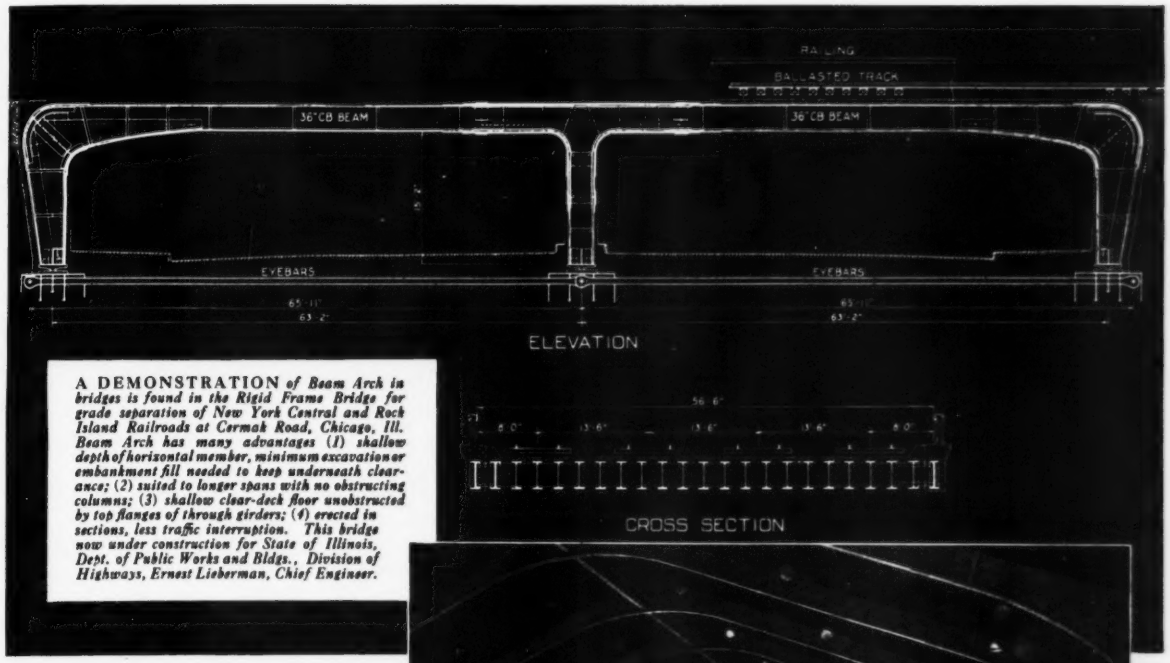
Twenty-nine companies have already arranged for space in the exhibit which the Bridge and Building Supply Men's Association will present coincident with the convention of the American Railway Bridge and Building Association at the Hotel Stevens, Chicago, on October 20-22. These companies are as follows:

Air Reduction Sales Company, New York
Armstrong Paint & Varnish Works, Chicago
Arrow Tools, Inc., Chicago
Barrett Company, New York
Binks Manufacturing Company, Chicago
A. M. Byers Company, Pittsburgh, Pa.
Celotex Company, Chicago
Dearborn Chemical Company, Chicago
Detroit Graphite Company, Detroit, Mich.
Paul Dickinson, Inc., Chicago
Joseph Dixon Crucible Company, Jersey City, N.J.
Duff-Norton Manufacturing Co., Pittsburgh, Pa.
Fairmont Railway Motors, Inc., Fairmont, Minn.
Ingot Iron Railway Products Company, Middletown, Ohio
Johns-Manville Sales Corporation, New York
Koppers Products Company, Pittsburgh, Pa.
Lehon Company, Chicago
Mall Tool Company, Chicago
Earl A. Mann & Associates, Chicago
Master Builders Company, Cleveland, Ohio
National Lead Company, New York
Otley Paint Manufacturing Company, Chicago
W. W. Patterson Company, Pittsburgh, Pa.
Pocket List of Railroad Officials, New York
Railway Engineering and Maintenance, Chicago
Ruberoid Company, New York
Thompson & Company
U. S. Gypsum Company, Chicago
U. S. Wind Engine & Pump Company, Batavia, Ill.

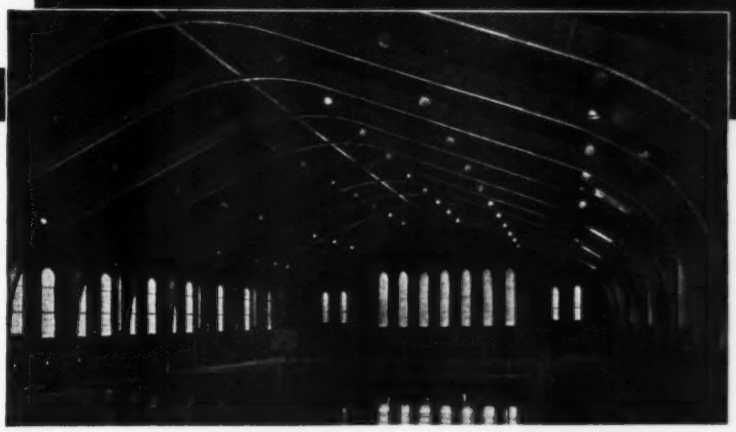
Announcing . . .

BEAM ARCH CONSTRUCTION

applied to Rigid Frame Bridge



A DEMONSTRATION *of Beam Arch in bridges is found in the Rigid Frame Bridge for grade separation of New York Central and Rock Island Railroads at Cermak Road, Chicago, Ill. Beam Arch has many advantages (1) shallow depth of horizontal member, minimum excavation or embankment fill needed to keep underneath clearance; (2) suited to longer spans with no obstructing columns; (3) shallow clear-deck floor unobstructed by top flanges of through girders; (4) erected in sections, less traffic interruption. This bridge now under construction for State of Illinois, Dept. of Public Works and Bldgs., Division of Highways, Ernest Lieberman, Chief Engineer.*



THE sweeping curve of roof construction and the vaulted profile of bridge spans can now use to advantage the Beam Arch as developed by American Bridge Company. In addition to its innate beauty it has many economies—it is fabricated from Carnegie-Illinois rolled CB beams; it is shipped in large sections to simplify and speed field erection; it has low maintenance costs for the large plain surfaces are easily inspected and painted, while offering no inaccessible surfaces or pockets to collect dirt.

Beam Arch construction is new and modern. It offers the ultimate in appearance, strength and economy. Call on us for additional information or suggestions.

THIS FIELD HOUSE *for University of Chicago built in 1931, the first major installation of American Bridge Company Beam Arch, demonstrated the advantages for buildings—(1) long span construction (spans up to 200 feet have been built); (2) no interior posts or deep trusses, unobstructed light, ventilation and vision; (3) balconies may be cantilevered from columns, no unsightly hangers above or posts below; (4) shallow depth of arch member, lower roof line reduces height of enclosing walls. Field House is 168'2" wide, 68' high at center. Architects, Holabird & Root; Associate Architect, Emery B. Jackson.*

A M E R I C A N B R I D G E C O M P A N Y

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UNITED STATES STEEL

Personal Mention

General

F. W. Biltz, assistant division engineer on the Reading, with headquarters at Reading, Pa., has been promoted to assistant to the general superintendent, with the same headquarters.

R. C. Kline, division engineer on the Atchison, Topeka & Santa Fe, with headquarters at Winslow, Ariz., has been promoted to assistant superintendent, with headquarters at Prescott, Ariz.

Engineering

Harold G. Watkins, engineer maintenance of way of the Akron, Canton & Youngstown, has been appointed to the newly-created position of chief engineer, with headquarters as before at Akron, Ohio. The position of engineer maintenance of way has been abolished. Mr. Watkins was born on July 2, 1890, at Plaistow, N.H., and entered railway service in June, 1911, in the construction department of the Boston & Maine. In November of the same year he was transferred to the maintenance of way department of the B. & M., where he remained until 1917, when he joined the Fourteenth Engineers of the United States Army. Two years later he returned to the maintenance of way department of the B. & M., remaining there until 1926, when he entered the service of the Akron, Canton & Youngstown as a roadmaster. Later in the same year Mr. Watkins was advanced to engineer maintenance of way, which position he continued to hold until his recent appointment as chief engineer.

R. D. Pierson, assistant division engineer on the Atchison, Topeka & Santa Fe, with headquarters at San Francisco, Cal., has been promoted to division engineer with headquarters at Winslow, Ariz., to replace **R. C. Kline,** whose promotion to assistant superintendent is noted elsewhere in these columns. **George W. Varnum,** roadmaster at Kingman, Ariz., has been promoted to assistant division engineer at San Francisco, to succeed Mr. Pierson.

Mr. Pierson was born on October 8, 1887, at Augusta, Ill., and received his higher education at the University of Illinois. He entered railway service on April 26, 1910, as a chainman on the Santa Fe at Winslow, Ariz. In May of the same year, he was promoted to rodman on construction on the Albuquerque division, and in August, 1911, he was appointed an inspector on road and trail construction in the Grand Canyon. From March, 1912, to November, 1915, he served as a rodman on construction and maintenance on the Albuquerque division and at the end of this period he became connected with the Interstate Commerce Commission as a computer with a party on railway valuation. In April, 1916, he was appointed a transitman on construction on the Santa Fe, and in the following year he was made an assistant engineer on construction on the Arizona division. From December, 1917, to January, 1919, Mr. Pierson was with the U. S. Army, where he attained the rank of second lieutenant, returning to the Santa Fe at the end of this period as a transitman on the Coast Lines. In January, 1921, he was advanced to assistant division engineer of the Arizona division, with headquarters at Needles, Cal., holding this position until October 1, 1929, when he was transferred to San Francisco. He was located at the latter point at the time of his recent promotion to division engineer.

Track

A. L. Kickhafer, roadmaster on the Chicago & North Western, has had his headquarters transferred from Ashland, Wis., to Ironwood, Mich.

J. A. MacDonald, a roadmaster on the Canadian Pacific, has had his headquarters transferred from Lauder, Man., to Deloraine, Man. **O. Koehler,** roadmaster with headquarters at Swift Current, Sask., has retired in accordance with the company's pension regulations.

R. W. Morrison has been appointed supervisor on the Reading, with headquarters at Philadelphia, Pa., succeeding **R. W. Torbert,** who has been transferred. **F. G. Keens** has been apopinted supervisor with headquarters at Lansdale, Pa., to succeed **W. G. Wieand** who has been granted a leave of absence.

O. A. Graham has been appointed supervisor on the Illinois Central, with headquarters at McComb, Miss., to succeed **Thomas A. Winborn, Sr.,** whose death on August 18 is reported elsewhere in these columns. **J. H. Edmonson** and **P. Moyer,** acting supervisors at Vicksburg, Miss., have been appointed supervisors with the same headquarters.

W. E. Chapman, acting supervisor of track at the Savannah (Ga.) Terminals of the Central of Georgia, has been appointed supervisor of track on the Andalusia district, with headquarters at Union Springs, Ala. **Horace Waters,** a roadway machine operator, has been appointed assistant supervisor of track at the Savannah terminals.

M. E. Spivey has been appointed roadmaster on the Atchison, Topeka & Santa Fe, with headquarters at Parker, Ariz., to succeed **C. I. Jones,** who has been transferred to Kingman, Ariz., to replace **George W. Varnum,** whose appointment as assistant division engineer is noted elsewhere in these columns. **C. A. Williams** has been appointed acting roadmaster of the Roswell and Carlsbad districts of the Pecos division with headquarters at Carlsbad, N.M., to succeed **W. E. Connell,** who has been transferred.

A. S. Wilson, a section foreman on the Canadian National at St. Norbert, Man., has been appointed acting roadmaster at Swan River, Man., succeeding **V. C. Hooper,** who has been transferred to Sioux Lookout, Ont., to succeed **J. H. McInnes,** who has been transferred to Warroad, Minn. Mr. Hooper succeeds **J. E. Gordon,** who has retired. **J. F. Roy,** an instrumentman on the Dauphin division, has been promoted to roadmaster, with headquarters at Fort Rouge, Man., to succeed **P. B. Valde,** who has retired. **J. F. A. Gosselin** has been appointed roadmaster at the Montreal (Que.) terminals, to succeed **H. Joly,** who has been appointed assistant roadmaster with the same headquarters.

Obituary

J. M. Harper, division engineer on the Vicksburg division of the Illinois Central, with headquarters at Vicksburg, Miss., died on September 2.

Eugene C. Bagwell, chief operating officer of the Seaboard Air Line, and formerly principal assistant engineer of this company, died on September 6 of heart disease. Mr. Bagwell was born on October 3, 1884, at Raleigh, N. C., and was graduated from the North Carolina State

Eugene C. Bagwell

college in 1904. He entered the service of the Seaboard Air Line in August of the same year as construction engineer, serving in that capacity until March, 1908, when he was appointed superintendent of the Charlotte Harbor & Northern (part of the Seaboard Air Line). From September, 1909, to April, 1910, he served as resident engineer, and on the latter date he became principal assistant engineer. Mr. Bagwell served in this capacity until April, 1914, when he was made assistant to the president. Three years later he became division superintendent, remaining in this position until February, 1925, at which time he was appointed general superintendent. Mr. Bagwell was promoted to operating assistant to the vice-president in February, 1928, and served in that capacity until May, 1928, when he became general manager. His title was changed to chief operating officer in the latter part of 1934.

Thomas A. Winborn, Sr., supervisor on the Illinois Central, with headquarters at McComb, Miss., whose death on August 18 was reported in the September issue, had been identified with the Illinois Central for 44 years. He was born on September 15, 1865, in Carroll county, Miss., and obtained his first railway experience

with the Southern. On January 28, 1892, he entered the service of the Illinois Central as a section foreman at Canton, Miss., being promoted to yard foreman, with the same headquarters, six years later. On May 27, 1907, Mr. Winborn was further advanced to supervisor of the Canton district, with headquarters at McComb, serving in this position continuously until his death.

The Channel Valve—The Ingersoll-Rand Company, New York, has issued an 8-page illustrated pamphlet devoted to its new Channel Valves for compressors. An unusual feature of this booklet is the manner of indicating the construction of the valves by printing views of the various parts on successive pages of transparent celluloid.

Subgrade Drainage.—The Armco Culvert Manufacturers Association, Middletown, Ohio, has published a 32-page illustrated booklet, known as Bulletin H-36, which is devoted to a discussion of subgrade drainage and its effect on the stability of the roadbed. While the discussion applies particularly to highway roadbeds, it is equally applicable to railroad subgrades. The discussion is divided into three parts, as follows: (1) Foundation or subgrade studies; (2) methods of subgrade stabilization; and (3) examples of subgrade drainage.

Wrought Iron in Salt Water Service.—This is the title of a 16-page bulletin comprising a report prepared by the engineering service department of A. M. Byers Company, Pittsburgh, Pa., on the service rendered by wrought iron when exposed to salt water. Following an introduction reviewing the technical reasons for the corrosion resistance of this material, the report presents a series of service records of wrought iron structures exposed to sea water, salt brine pipes, brine protection plates on railway bridges and other uses involving exposure to liquids containing salt. The text is illustrated with photographs of specific structures.

Airco Electric Welding Products—A comprehensive 32-page catalogue issued by the Air Reduction Sales Company, New York City, gives the latest data on the various electric welding products manufactured and sold by this company, including electrodes, arc welding machines and a variety of miscellaneous apparatus. The first section of the catalogue is devoted to Airco electrodes, of which some 39 are listed with statements concerning their physical properties and recommended use. The second section of the catalogue deals with miscellaneous welding apparatus, including helmets, face shields, cables, gloves, electrode holders, etc., while the third section describes and illustrates the various models of Wilson electric welding machines available for different classes of welding work. A last section includes a group of tables especially useful to the welder, such as an arc welding table, tables of recommended arc voltages, recommended amperages and approximate weights of Airco rods, and a summary statement of the causes of bad welds.

Supply Trade News

General

The name of the **National Carbide Sales Corporation,** New York, has been changed to the **National Carbide Corporation.**

The **Carnegie-Illinois Steel Corporation,** Pittsburgh, Pa., has announced that hereafter the trade name "USS Carilloy" will be used to identify alloy steels produced by this company, which is a subsidiary of the **United States Steel Corporation.** It is emphasized that the new name does not signify a new product, nor does it apply to any single alloy steel. It is simply a designation for the entire group of alloy steels which were previously marketed as Carnegie-Illinois Alloy Steels.

Personal

Hoyle Jones, formerly president of the Superior Tube Company, has been appointed district sales manager of the **Republic Steel Corporation,** with headquarters in Tulsa, Okla.

J. E. Buckingham has been elected vice-president in charge of sales in the Western district of the **Lincoln Electric Railway Sales Company,** Cleveland, Ohio. Mr. Buckingham's headquarters will be at Chicago, where he has for the last

J. E. Buckingham

five years been western regional manager of the Railroad division of the **Worthington Pump & Machinery Corporation.** Mr. Buckingham first entered railway service in 1900, with the Union Pacific System, serving with this company for 8 years at Salt Lake City, Utah, and Omaha, Neb. At the end of this period he became master mechanic for the Union Stock Yards Company, and subsequently he entered the service of the Wells Fargo Express Company as superintendent of the motor and refrigerator division. Mr. Buckingham's experience also includes service with the railroad departments of the Baldwin Locomotive Works, the Standard Steel Company and the Associated Oil Company. For the last 14 years he has been connected with the Railroad Sales Division of the Worthington Pump & Machinery Corporation.

George I. Wright has been appointed manager transportation department of the **Westinghouse Electric & Manufacturing Company,** with headquarters at East Pittsburgh, Pa. He has charge of engineering and sales of equipment supplied to the transportation industry. Mr. Wright is a native of East Orange, N. J. He was

George I. Wright

educated in California and received his degree in electrical engineering from Standford University in 1913. Prior to his association with the Reading Company, in 1927, he had been active in various capacities with the Southern Pacific, and was assistant electrical engineer of the Illinois Central. During the World War he served as lieutenant on the U.S.S. Montana and also was on submarine construction. In 1927, he joined the Reading Company, where he had charge of the design and installation of the Philadelphia suburban electrical system of that railroad. In 1931 he was made chief electrical engineer of this system and later also of the Central of New Jersey.

E. W. Backes, chief engineer and western representative of Standard Equipments, Inc., with headquarters at Chicago, has resigned to become sales engineer of the **Rail Joint Company,** with headquarters at Chicago.

Frederick S. Cook has been appointed Pacific Coast manager of the **Robert W. Hunt Company,** Chicago, with headquarters at San Francisco, Cal. Since 1919 he has been vice-president and secretary of the McCraken-Ripley Co., Portland, Ore.

James S. Hearons has been appointed assistant manager of sales of the Railroad division of the **Inland Steel Company,** Chicago. Mr. Hearons attended school in the East, and began work as a special apprentice on the Erie in 1906, and later became associated with the Illinois Central. During the World War he served in the A. E. F. as captain in the Engineering division. Prior to his Inland appointment, Mr. Hearons was assistant to the president of the Clark Equipment Company.

GOVERNMENT COSTS EQUAL *one-third of all your pay*

"What! *One-third of all my pay for government?*"

OF COURSE! Perhaps you didn't realize it. It's an expensive business running the national, state and local governments—the way spendthrift politicians waste YOUR money!

The cost equals almost ⅓ of *all* you earn, but that is supposed to be a secret. That's why they *hide* your taxes! Take bread, for example. 53 taxes are in every loaf. As for gasoline—40 to 60% of the price you pay goes for taxes.

The tax bill is so great EVERYBODY has to pay—the rich and the poor. (All the riches of all the rich people in the country wouldn't pay one year's taxes!) You just can't get away from it.

One-third of your weekly pay will keep on going for government unless you do something about it.

WHAT TO DO

Our annual taxes can be less, because the cost of government can be reduced.

It has been estimated that the true economy of statesmen, not the spending of self-seeking politicians, would reduce the nation's tax bill by BILLIONS of dollars. And, without sacrificing good government! We would still have money for ALL needed relief—all important projects.

It's up to you to bring your taxes down—by putting a stop to endless EXTRAVAGANCE and waste.

So make this resolution and keep it:

"I resolve to oppose every officeholder who cannot prove to me that he has used all his influence to reduce the cost of government."

Remember this resolution. You have all the power. You alone can oust political spendthrifts and put clear-headed lawmakers in their places.

ACT TODAY

Don't wait. You can stop tax wasting QUICKLY! Write these three letters. Mail them today:

One to your MAYOR *(or the County Clerk, if you live in the country). One to your* GOVERNOR. *One to the* PRESIDENT.

Write only one sentence in each letter and sign your name and address. Say: *"I want the cost of government reduced!"*

BUT DO IT TODAY! It's your job, Mr. and Mrs. Public. You alone can protect yourself. Don't fail. Let the wasteful spender know his game is up. Let's all help give America back to the people!

Write this letter today!

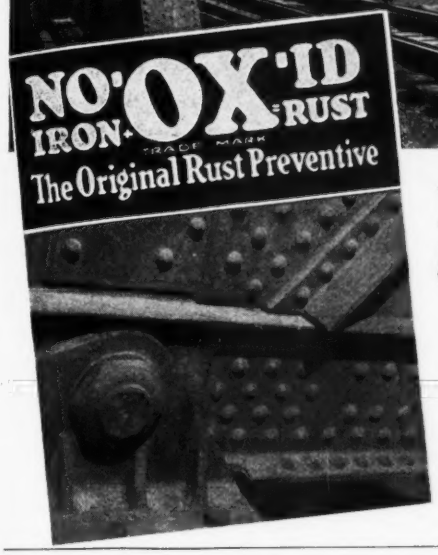
"I want the cost of government REDUCED!"

MAIL COPIES OF IT TO:

1. **Your Mayor (or your County Clerk)**
2. **Your Governor**
3. **The President of the United States**

REGISTER—VOTE—Give your support to candidates, regardless of party, who WILL cut the waste out of government.

Space for this message is provided by Railway Engineering and Maintenance because of a firm conviction that a reduced cost of government is vital to the interests of all its readers



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Evaporation of salt laden moisture combined with intense sun rays is most destructive to steel. There is no evidence of rust action on this structure completely protected the NO-OX-ID way, although the tide washes in under it, storms spray it and the sun rays and wind beat upon it.

NO-OX-ID kills the rust that is started and prevents new rust from forming—at an unmatched economy in cost, and maintenance without loss of metal.

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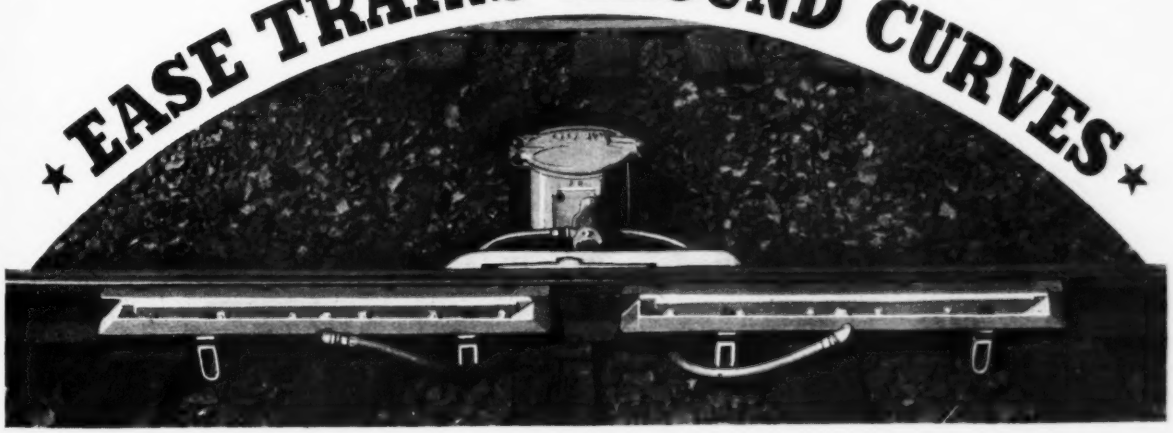

MECO CURVE-RAIL AND WHEEL-FLANGE LUBRICATORS

Year around protection for thousands of miles of curve territory

- ★ Installed *anywhere* in five man-hours—or less.
- ★ Requires no drilling—clamps to rail.
- ★ Readily reapplied to rails of heavier or lighter section.
- ★ Lubricates at low cost per mile of curve territory protected.
- ★ Meets every requirement of track and traffic, using same lubricant all year around.

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ALPHABETICAL INDEX TO ADVERTISERS and list of their products


Never give RUST a "BREAK"..
For Sure Protection Use...
DUTCH BOY RED-LEAD
● The slightest opening in a paint film—the smallest break—is an invitation to rust to begin its destructive work. Never give rust a "break." Keep it from getting a start by painting your metal surfaces with Dutch Boy Red-Lead. Here is a paint that provides a solid, tough, tenacious coating—one that not only keeps out moisture but also resists the other common causes of corrosion, such as gases, smoke and salt water.
Dutch Boy Red-Lead comes in both paste and liquid form, the latter including a quick-drying type for use when allowable drying time is short. The pigment in every case is pure red-lead that contains more than 97% Pb_3O_4, thus assuring easier application, higher spreading rate and a uniform film of greater density.
For complete information on protecting iron and steel against corrosion, send for our free booklet, "Structural Metal Painting." It covers such subjects as the conditions affecting the life of paint on metal, proper paint formulation, testing and judging the value of paint, estimating areas and costs.
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